155 P.

THE Radio Constructor

RADIO
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ELECTRONICS

VOLUME 18 NUMBER 10
A DATA PUBLICATION
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May 1964

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A high performance, low cost receiver for the discriminating listener. Frequency coverage: 600 kc/s – 1.5 Mc/s and 1.7 Mc/s – 32 Mc/s.
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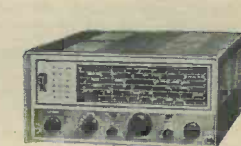

RG-1

RA-1

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sinclair NEWS

No. 2 MAY/JUNE, 1964

And now an Amplifier for the Micro-6

This month, we announce a new design for constructors—the Sinclair TR.750. Basically, it is intended as a companion power amp for the Micro-6 since so many have asked us for it, but whoever builds this amplifier will find it useful for a lot more applications as well. In common with other Sinclair designs, the TR.750 is a micro-miniature instrument with original features and enormous power. In fact, it is so small, that you could put it together with the Micro-6 into an empty 20-cigarette packet, and have room to spare! Yet the TR.750 incorporates its own volume control and on-off switch, and has an undistorted output of three-quarters of a watt.

Using these two Sinclair units, you can have a first-class car radio which can be fitted with an absolute minimum of inconvenience. Or you can make a unique two-unit portable or home receiver with loudspeaker. You can use your "Slimline" in the same way also, if you wish. By using the appropriate accessories, high-fidelity standards for domestic listening are easily obtained. A pair of TR.750s can be used in stereo. In fact, wherever extreme compactness is required together with power and quality, you will find the Sinclair TR.750 the very job for you.

AFTER THE LAUNCHING, THE DELUGE

The Micro-6 has met with an even more enthusiastic response from set builders than did our original Slimline, which nevertheless continues to be very popular, particularly with newcomers to transistor building. It will come as no surprise, therefore, to constructors who already know what Sinclair stands for, to learn that letters of praise and appreciation are now pouring in daily as more and more builders make and use the smallest radio set in the world.

F.W., Luton writes—"Am very pleased with the quite remarkable results obtained from this very small receiver."

J.C.F.M., London, W.14 says—"The set worked very well indeed and I congratulate you on its performance." Similarly, *D.F., Monkseaton, Northants*, congratulated us on the design of the set, and continues, "The performance is quite unbelievable. I have shown it to a number of my friends and they have all been very impressed."

From *Abingdon, Berks, S.H.L.* recalls difficulties he had with a set three years ago and goes on to state: "Not only was I able to build your set successfully straight off, but the initial price was a pound less, and the performance in the sensitivity, selectivity and indeed every other way was fantastically better." *G.J., Nottingham*, favoured us with detailed observations for which we thank him. "I very much enjoyed the four or five hours work necessary to complete it (the Micro-6) which was accomplished almost without swearing, unlike most other sets I have made," writes *G.J.* "When finished, it worked at once. I consider the conception brilliant and I am very pleased with it. It has, of course, aroused much interest amongst my friends."

"THE FINEST LITTLE SET"

"Having been a transistor fiend for the last eight years, I must say it is the finest little set I have ever constructed. Please send me one more of these marvellous little instruments," writes *R.K., Preston*.

In *Aylesbury, Bucks, J.G.H.* logged "3 B.B.C. programmes and at least 12 foreign stations with good selectivity, more strength than was needed and no fading on Luxemburg."

"LEAVES MY 6-TRANSISTOR SET STANDING"

S.H., Wilmslow, Cheshire, is "truly amazed at the quality and sensitivity of this set. It leaves my 6 transistor set standing. Volume enables programmes to be heard clearly even in a noisy metal framed department store."

And so we could go on. As with all letters from which we quote, the originals may always be seen at our offices.

TWO-WAY PROTECTION FOR YOU

Remember, when you buy a Sinclair design, you are fully protected by our unique guarantee whereby should you not be immediately satisfied with your purchase, your money is refunded without question. And for those whose building may need some servicing, our own technical service department can quickly put things right for you.

Referring back to letters sent to us, we should point out that we also get our share from constructors who build other Sinclair designs including the Signal Injector, the Micro-Amplifier and the Slimline as shown overleaf.

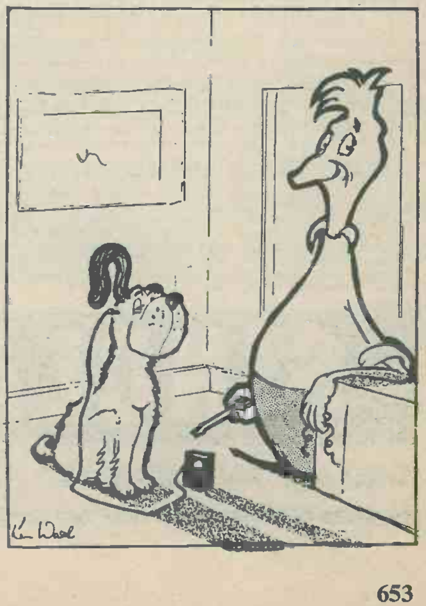
C. M. Sinclair

MICRO-6 A SENSATION AT 1964 PARIS ELECTRONIC COMPONENTS SHOW

When exhibited at the 1964 Paris Electronics Components Exhibition, the Micro-6 created an instant sensation. Nothing like it had ever been seen or heard before in Europe, and now demand for this amazing receiver is growing rapidly on the Continent as well. Next it is expected that the world's smallest receiver will be on show at the New York World's Fair.

Says **Mike Farrard** *our favourite customer*

"He buries it in the garden if he doesn't like the programme"



THREE MORE PAGES OF SINCLAIR NEWS FOLLOW THIS

DESIGNS THAT ARE YEARS AHEAD

The triumph of Sinclair designs is twofold—firstly they embody advanced techniques using transistors and micro-miniature components in a variety of attractive applications; secondly they make it possible for anyone to build with assured ease and success and thereby enjoy using really advanced equipment. *All designs are provided with well-presented instructions.*

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★ **PROMPT, PERSONAL ATTENTION TO ALL ORDERS**

FIRST OF THE SINCLAIR MICRO-RECEIVERS

This is the set that gives you Europe in the palm of your hand. It has a self-contained ferrite rod aerial and accommodation for a standard PP5 battery, yet measures only 2 15/16" x 1 11/16" x ¾". Tunes over the entire medium waveband and can be used in cars, trains and buses. Using Sinclair MAT Transistors and special circuitry, it provides great power and quality; listening is by means of the lightweight earpiece provided. Building is particularly easy.

SINCLAIR SLIMLINE

All parts, including royal blue and gold case, earpiece, and instructions, come to

49/6

SINCLAIR MICRO-AMPLIFIER

AS USED IN LABORATORIES, RESEARCH ESTABLISHMENTS, ETC.

Actual size

Smaller than a 3d. piece.

★ *With detailed instructions, applications data and circuitry*

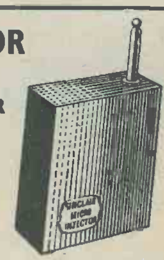
28/6

This fantastically small, powerful amplifier is smaller than a 3d. piece. With a frequency response from 30 to 50,000 c/s ± 1dB, and power gain of 60dB (1,000,000 times) it makes a superb broadband R.F. amplifier as well as a sub-miniature hi-fi amplifier with an output suitable for any earpiece or even loudspeaker. This amplifier makes a valuable tool in the hands of the experimenter, and is widely used in industry, research, etc. With MAT Transistors, micro-miniature quality components, micro-printed circuit and instructions.

40 dB gain at 1 Mc/s.

SINCLAIR MICRO-INJECTOR

THE SMALLEST AND MOST EFFICIENT OF ALL INJECTOR TEST DEVICES



It is amazing how useful this precision instrument is. Using two MICRO-ALLOY TRANSISTORS it generates and injects a test signal into any part of a receiver or amplifier at any frequency from 1 kc/s to 30 Mc/s. By this means the location of faults can be rapidly found.

The Sinclair Micro-Injector is powered by a 6d. standard battery which will last for about 6 months. Its size is 1 4/5" x 1 3/10" x ½", excluding the probe which is 3/5" long, by far the smallest instrument of its kind available. Assembly is extremely simple.

All parts with instructions come to **27/6**

Ready built and tested **32/6**

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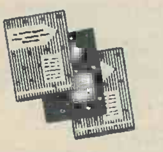

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★ "Tested Short Wave Receivers Using MATs"	*Post free*	5/6
★ "Tested Superhet Circuits for Short Wave and Communication Receivers, using MATs"	*Post free*	6/6

All three ordered together, 16/6

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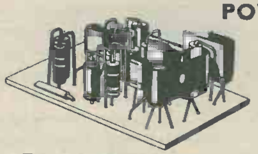
WITH COMBINED PRE-AMP. AND ½ WATT POWER AMPLIFIER



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Uses 5 matched transistors and temperature compensating diode to give transformerless undistorted output of 500mW, into 15 ohms. Sensitivity —0.5mV. Power gain 80dB. Frequency response 50 c/s to 20 kc/s ±3dB. Size 2¼" x 1½" x ¾". Operating voltage 9V.

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MAT 100	High gain low level	7/9
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MAT 120	High gain, medium and high level	7/9
MAT 121	Extra high gain, medium and high level	8/6
ADT 140	For FM, TV, VHF and UHF	15/-

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SINCLAIR MICRO-6 — SEE PREVIOUS PAGES

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Transistor Audio Generator

By G. C. Dobbs, G3RJV

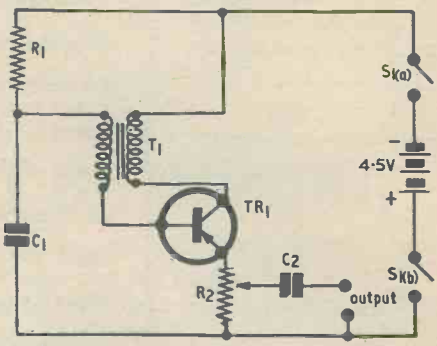
A neat and inexpensive unit employing non-critical component values

FREQUENTLY, DURING THE CONSTRUCTION OR servicing of an amplifier, tape recorder, or the audio stages of a receiver, one requires to inject a suitable test signal. The author was recently faced with such a problem during the construction of a tape recorder. Rather than resort to "finger on the grid" methods, a simple audio generator was quickly constructed from bits and pieces about the shack. This little unit proved to be so successful that it was built up into a permanent piece of equipment.

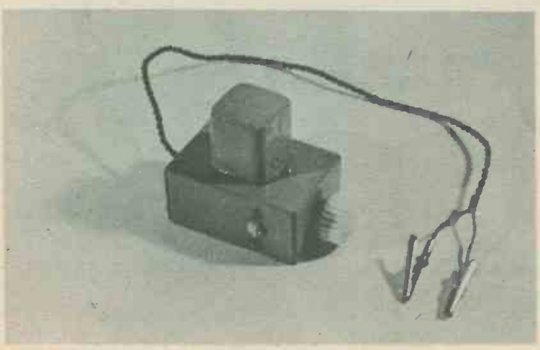
The Circuit

No originality can be claimed for the circuit, which is basically a form of Hartley oscillator. The feedback is maintained by inductively coupling the collector of the transistor to the base through a small audio transformer, T_1. The output is taken from the emitter resistor which is a potentiometer, and which also acts as an output amplitude control.

The oscillator requires very few components and is very cheap to build. The transistor used was an OC71, although any reasonable surplus audio transistor would have done the job. The choice of transformer is not critical, and any low ratio audio type should perform quite well in this circuit. The windings should have a fair number of turns and the resistance of each should not exceed 2kΩ. An ideal transformer is an intervalve component with a ratio between 1:1 and about 5:1. C_1 and the output capacitor C_2 should preferably be low voltage miniature types, and the potentiometer can be any suitable type between 1 and 5kΩ. The power required was at 4.5 volts, and a battery was made up for the job. This consists of three 1.5 volt sections connected in series. Three U12 cells were taped side by side and connections soldered directly on to the ends. A miniature slide-type switch was used in the $S_{1(a)\,(b)}$ position.



Circuit diagram of the transistor audio generator



Above-chassis view of the generator

Components List

Resistors
R_1 270kΩ ¼ watt 20%
R_2 1kΩ to 5kΩ potentiometer

Capacitors
C_1 0.1μF
C_2 0.1μF

Transistor
TR_1 OC71, or similar audio type

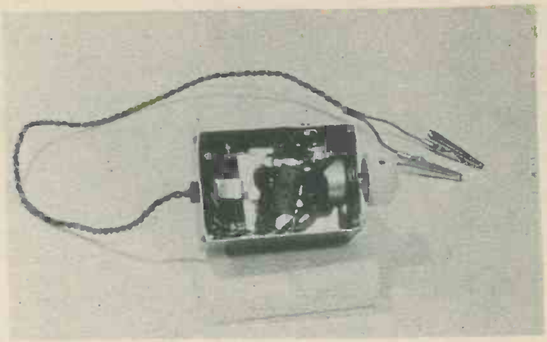
Transformer
Intervalve transformer (see text)

Switch
$S_{1(a)\,(b)}$ d.p.s.t. slide switch

The complete unit was built on an aluminium chassis measuring 3 x 2 x 1½in deep, this giving generous room for construction. The transformer was mounted on the top of the chassis, with a cut-down i.f. transformer can providing a screen. The transformer leads were taken below the chassis through two slots. The potentiometer was mounted on the front, and the switch on the left hand side of the chassis. To provide a handy output a piece of twin flex was taken through a ¼in grommet at the back, two crocodile clips being attached to the end for connections. An aluminium clip held the batteries in place in the rear of the chassis.

Switching On

When the unit has been completed, a pair of high resistance headphones should be connected across the output clips, and the power switched on. If an audio tone is not heard, the transformer will probably have been connected in the wrong phase, and the connections to one winding should be reversed.



Below-chassis view showing component layout

The prototype has been in use for several months and has, during this time, served many purposes. It has been used as a service instrument, a morse oscillator, a modulation checker and there is even a possibility of its being used to provide a c.w. note for an s.s.b. transmitter.

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

Oscilloscope, Type 10, No. 10SB/180.—A. Holt, 78 Rathmore Crescent, Southport, Lancs, requires the loan or purchase of the service manual or circuit diagram.

* * *

Marconi HP.112 VHF Transreceiver (Mobile Unit).—W. Burke, 6 Belgrave Terrace, Glasgow, W.2, wishes to obtain service manual or circuit diagram, also any data on the associated vibrator power unit.

* * *

Indicator Unit Type 62A.—G. A. Cables, "Tullich", Beaconhill Road, Milltimber, Aberdeen, would like any information on usage or circuit details.

* * *

Transmitter/Receiver B44 Mk. II.—A. E. Harvey, 39 Curlieu Road, Oakdale, Poole, Dorset, wants circuit diagram, manual and/or any other information. Either loan or purchase, all expenses met.

* * *

Verdik Tape Recorder.—R. E. Norgan, 29 Howeth Road, Ensbury Park, Bournemouth, Hants, requires the service sheet. Valve line-up is 6BR7, 6BW6, 12AX7, 6X4 and 6E5GT. All expenses met and all letters answered.

* * *

Hallicrafters Marine Radiophone Model HT-11B.—EA1 F. Matimong, CPO's Mess, *H.M.S. Osprey*, Portland, Dorset, is in urgent need of circuit diagram or any other data.

Marconi CR300/1 Receiver.—R. Scrimgeour, 19 Wellington Street, Dundee, Angus, requests circuit or any other information.

* * *

National HRO-MX Receiver.—P. R. Whittle, 94 Newhouse Crescent, Watford, Herts, wishes to obtain the manual or circuit.

* * *

G.E.C. Overseas 7 (BC4178L).—W. Hunter, "Hazeldene", Ballygally, Larne, Co. Antrim, N. Ireland, requires service sheet or circuit, loan or purchase.

* * *

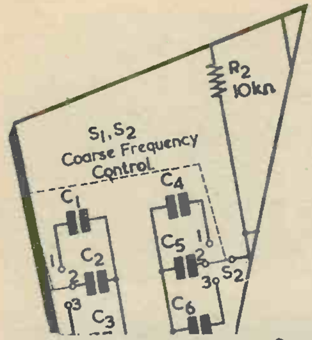
P.P.I. Indicator Type ID-84/TPS-1B.—M. Turner, 24 Oakleigh Avenue, Off Green Lane, Bolton, Lancs, requires circuit diagram for this unit which is part of the American radar set Type AN/TPS-1B.

* * *

CR100 Receiver.—R. Armstrong, 63 Summerfield Road, Solihull, Warks, wishes to buy or borrow circuit or any other details of this receiver.

* * *

No. 19 Set.—P. I. Peters, 59 Manvers Road, Swallow Nest, Sheffield, wishes to obtain circuit or any other data.



suggested circuits

The circuits presented in this series have been designed by G. A. French, specially for the enthusiast who needs only the circuit and essential data

No. 162 Record Player Amplifier with Microphone Input

Many record players, these days, are used almost entirely for the reproduction of "pop" music. As such, a very attractive additional feature consists of fitting a preamplifier and mixing circuits which allow a microphone to be plugged into the record player amplifier. The microphone may then be used for "accompaniments" with the record being played; a facility which will appeal especially to the younger members of the family. The availability of a microphone input can have more serious applications also, and could include such instances as voice training or the provision of commentaries to home movies and the like.

This month's article describes a circuit which should adequately meet the requirements of a combined record and microphone amplifier. Although emphasis has been placed on economy, the amplifier is still capable of offering an output in excess of 5 watts as well as having a chassis which is fully isolated from the mains by way of a double-wound transformer. The amplifier does not fall into the high fidelity category (using the term in its undebased sense) but it can still offer a high level of quality, this being comparable with any valve radio or record player having a single-ended output stage.

The Circuit

The circuit of the amplifier appears in Fig. 1 and, as may be seen, is quite straightforward and free from complication.

The microphone input is applied to the grid of $V_{1(a)}$ by way of C_1. The cathode of $V_{1(a)}$ is connected direct to chassis, grid current bias being provided by the high value grid resistor, R_1. The microphone employed may be a crystal type or a moving coil type fitted with its own step-up transformer to provide a high impedance output. Capacitor C_1 is included to prevent microphones of the latter type from reducing the grid-cathode resistance and, thereby, the grid current bias.

The amplified microphone signal voltage appears at the anode of $V_{1(a)}$, and is applied to the Mic. Volume control, R_4, via C_3. The signal level tapped off by the slider of R_4 is then passed to the grid of $V_{1(b)}$ via R_5. Also passed to this grid via R_7, is the signal obtained from the Gram Volume control R_6. Resistors R_5 and R_7 are included in circuit to reduce interaction between the two volume controls. Without these resistors, one signal would be subject to very heavy attenuation as the slider of the volume control for the other signal approached the earthy end of its track. Even with R_5 and R_7 in circuit there is still some interaction but the effect, in practice, will not be serious. R_5 and R_7 are given values which allow the external grid-cathode resistance for $V_{1(b)}$ to remain within its limiting value of 1MΩ for operation with cathode bias.

$V_{1(b)}$ amplifies both microphone and gram signals, these being applied via C_6 to the grid of V_2. This valve amplifies in normal manner, feeding the loudspeaker by way of output transformer T_1. A top-cut tone control circuit, given by C_7, R_{13} and R_{14}, is connected across the primary of T_1.

H.T. and heater voltages are given by mains transformer T_2, the h.t. circuit employing a bridge rectifier consisting of diodes D_1 to D_4. Bridge h.t. rectifiers have been used extensively by commercial receiver and record player manufacturers for quite a few years in applications of this nature, but they do not seem to feature very frequently in home-constructor designs. The advantage of the bridge rectifier is that it offers full wave rectification from a single h.t. winding and, therefore, enables a cheaper and smaller mains transformer to be employed than is the case with the two-diode full wave circuit. Suitable rectifiers and transformers are currently available on the home constructor market.*

Following conventional practice, the rectified h.t. voltage appearing across reservoir capacitor C_9 is applied to the anode circuit of V_2, whilst the smoothed voltage across C_4 is fed to the screen grid of this valve. Since the heavy anode current of the output valve does not flow through the smoothing resistor, the latter suffers a low level of dissipa-

* For example, a mains transformer with secondaries of 250 volt 60mA and 6.3 volt 2A is available from R.S.C. (Ltd.), 5 County Arcade, Leeds 1; and a 250 volt 75mA contact cooled bridge rectifier is available from Henry's Radio Ltd., 303 Edgware Road, London, W.2.

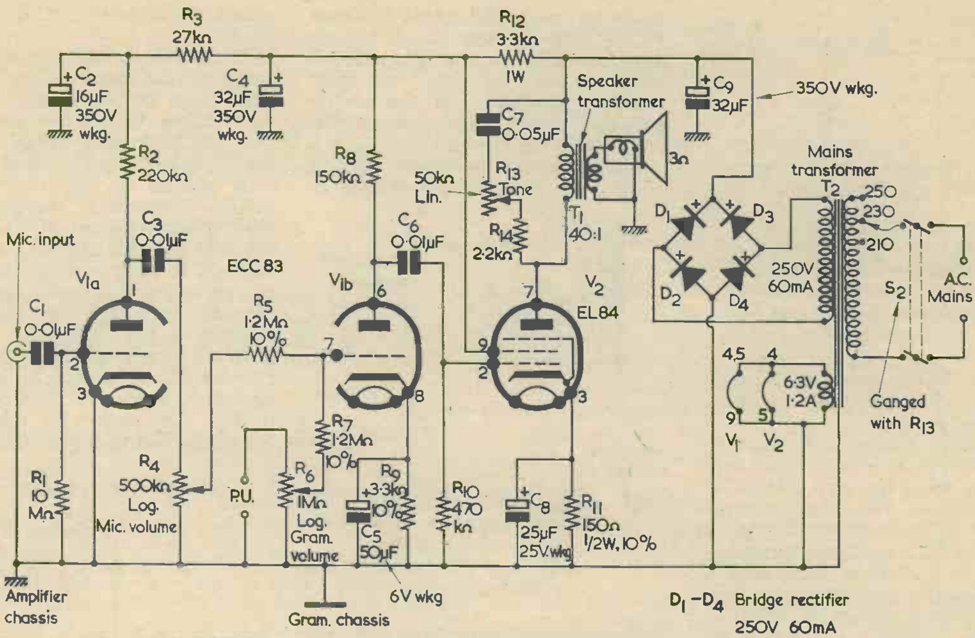


Fig. 1. The circuit of the combined record player and microphone amplifier

tion. Also, a relatively high h.t. voltage is available for the anode. The anode of $V_{1(b)}$ obtains its h.t. supply from the smoothed voltage across C_4, further decoupling, given by R_3 and C_2, being provided for the anode supply to $V_{1(a)}$.

It will be noted that the amplifier does not incorporate negative feedback. This has been omitted as it is anticipated that constructors making up the amplifier will use an inexpensive output transformer in the T_1 position. When an output transformer of this type is employed, it frequently happens that only a low level of feedback (say to the cathode of $V_{1(b)}$) is possible before instability sets in, with the result that no great advantage accrues from the use of the feedback. In the interests of simplicity, therefore, feedback has been omitted from the present circuit.

Further Points

There are several further points which require discussion.

The first of these is that the pick-up is shown as being connected direct to the Gram Volume control, R_6. This method of connection should give acceptable results with many crystal pick-ups, although it may be found in some cases that pick-up output is too great. In such an instance, R_6 may be reduced to 500kΩ and a resistor having a value lying between 470kΩ and 1.5MΩ inserted in series with the upper end of its track. When this alternative circuit is employed, it may be beneficial also to shunt the volume control or the series resistor with a capacitor of 50 or 100pF.

The Mic. Input socket may be of the coaxial type. Alternatively, a jack socket could be used. If a jack is employed, it would be helpful to fit a type which short-circuits the input when the jack plug is withdrawn, as shown in Fig. 2. This will reduce the effect of hum pick-up in the grid circuit of $V_{1(a)}$ when the microphone is not plugged in, and which could become audible when the amplifier is used with records only. Such hum, if at low level, will be partly masked by background noise (and damped out if a moving coil microphone is used) when the microphone is plugged in.

The speaker transformer may, as inferred above, be an inexpensive component. Its primary should be capable of carrying a current of 50mA.

As will occur immediately to readers who have had experience of audio amplifier work, there will be a strong risk of acoustic feedback if the microphone is placed too close to the loudspeaker when the amplifier is set to a high gain level. This acoustic feedback will result in the generation of a howl. If the microphone is used in the same room as the speaker it should be positioned behind the latter (assuming that the speaker is almost completely enclosed at the back) whereupon sufficient amplification without acoustic feedback should be available to meet the requirements of "pop sessions" and the like. Obviously, the Mic. Volume control will need to be set, under these conditions, to a level slightly below that at which acoustic feedback occurs.

None of the component values in Fig. 1 are in any way critical, and it should be possible to employ resistors with 20% tolerance in all positions except those where a 10% tolerance is specifically indicated. All resistors may be ¼ watt types unless otherwise shown.

It is doubtful whether any difficulties will arise due to instability at other than audio frequencies. Nevertheless, there *is* a high level of gain in the amplifier, whereupon such instability becomes feasible. Should this occur it may be cleared by inserting a grid stopper resistor of some 5 to 20kΩ in series with the control grid of V_2. The resistor should be fitted such that its body is close to the valveholder tag.

Reducing Hum

It is probable that the greatest difficulty likely to be encountered in making up the amplifier is the

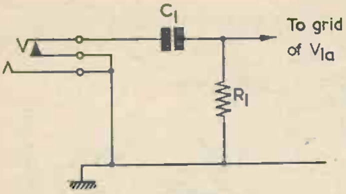


Fig. 2. If a jack is employed for the microphone input socket, this may have an earthing contact, as shown here

obviation of excessive hum. Because of this it will be advisable to take a number of precautions.

The heater wiring to V_1 and V_2 should be tightly twisted and kept well away from the grid circuits of $V_{1(a)}$ and $V_{1(b)}$. The chassis connection to the heater circuit should be made near the mains transformer.

Valve V_1 should be fitted with a screening can, and screened wire should be employed for the wiring in $V_{1(a)}$ grid circuit. It would be preferable to employ the bus-bar method of chassis connection, the bus-bar being a length of heavy-gauge wire connected to chassis at one point only. In this instance, the best point would be at the earthy side of the Mic. Input socket. Chassis connections should then be made to this bus-bar in approximately the same order as they appear in the circuit. The heater earth may, on the other hand, be made to chassis instead of the bus-bar as was just mentioned. If a coaxial socket is employed for the gram pick-up, its earthy side should be connected to the bus-bar and not to chassis. Since, however, the amplifier will probably be employed in the same cabinet as the gram deck it may not be necessary to employ a chassis-mounting socket for the pick-up in any case, direct connections being made instead. The metal housings of R_4 and R_6 may be at chassis potential (this being usually ensured automatically by way of their mounting bushes) but the earthy ends of their tracks should be returned to the bus-bar.

The gram deck metalwork may be bonded to the amplifier chassis at any convenient point. The screened cable to the pick-up should only be earthed to the appropriate point on the bus-bar, and care should be taken to avoid any connection between this screening and the metal-work of the gram deck.

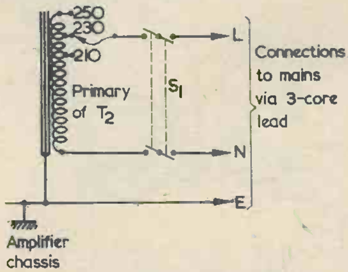


Fig. 3. Where three-way mains sockets are available, the amplifier chassis may be directly connected to earth

Due to the isolation offered by the mains transformer, it is possible to connect the amplifier chassis direct to a reliable earth. Thus, if a three-way mains socket is available, the amplifier may be fitted with a three-core mains lead as shown in Fig. 3, whereupon the use of the earth connection may further assist in reducing hum. It should be adequate to make the earth connection to the chassis at some convenient point near the mains transformer, and not necessarily to the bus-bar.

There is a slight possibility of modulation hum, and this may usually be cleared by reversing the mains connections to the primary of T_2.

These precautions may appear to be somewhat excessive for a simple three-stage amplifier, but they are nevertheless worthwhile because of the very high gain offered by $V_{1(a)}$ and $V_{1(b)}$ in cascade. Final tests for hum should be made with both volume controls at maximum and with the grid circuit of $V_{1(a)}$ open-circuit. If a jack such as that shown in Fig. 2 is used, hum tests should be carried out with a dummy jack plug inserted in order to break the earthing contact.

It will be noted, incidentally, that the mains on-off switch, S_1, is ganged with R_{13}, instead of with either R_4 or R_6. The reason for this is that the mains wiring does not then have to approach the grid circuit of $V_{1(b)}$, and there is less risk of hum in consequence.

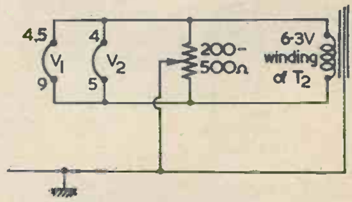


Fig. 4. When excessive hum is difficult to eradicate, it will prove helpful to add a humdinger

If excessive hum is still troublesome despite all the measures referred to above, it will be necessary to fit a humdinger, as shown in Fig. 4. This is a pre-set potentiometer having a value lying between 200 and 500Ω and it should be mounted near the mains transformer. It is adjusted for minimum hum. If desired, it may be replaced, after setting up, by two fixed resistors having appropriate values.

PYE WINS LARGE CONTRACT IN DENMARK

What is believed to be one of the largest single contracts ever placed for a mobile radiotelephone network has been awarded by the Danish State Police to Pye Telecommunications of Cambridge, England.

This contract, valued at about £250,000, is for a fixed and mobile radiotelephone network to cover the whole of Denmark. The radiotelephone equipment, which is to be fitted at police headquarters throughout the country and in police cars and on motorcycles, is of the most modern design employing fully transistorised receivers and instant heating transmitter valves. Transmissions from mobiles may be picked up at any of a number of reception points and at the Central Headquarters. Automatic voting equipment selects the best signal at all times.

The tender was awarded to this British company in competition with both international and local manufacturers and after extensive field trials by the Danish Police.

High Quality TAPE AMPLIFIER

By B. M. SANDALL, G3LGK

IN THE DESIGN OF A TAPE AMPLIFIER INTENDED FOR use with the smaller type of deck, a number of basic requirements have to be taken into account if optimum performance is to be obtained. These requirements will now be considered.

Basic Requirements

1. With the availability of high quality programmes, a recorder should do justice to the full frequency range provided. This implies a good frequency response between 40 and 10,000 c/s for the average programme. Also, for the best sounding result, the frequency response outside these limits should not vary abruptly but, rather, fall away gradually.

2. With the tape heads now available, attention has to be paid to good response, such that the required frequency range can be obtained at 3¾in/sec on most decks (and at 1⅞in/sec on a few outstanding models). The small deck can then give excellent results in this respect.

3. To obtain the greatest realism in the final result, the signal-to-noise ratio must be good, whereupon, in tape equipment, two main problems arise. The first of these is that the gain required in a tape playback system is so high that even the smallest stray hum pick-up in the early stages of the amplifier can be disastrous. In the system to be described in this article, hum is negligible even with playback gain set to maximum, a circumstance which is seldom necessary. The second problem is that "hiss" from the tape system may arise from the use of unsuitable components, circuitry or tape. The circuit to be described here ensures that the hiss reproduced at full gain is due to the tape rather than circuit shortcomings, and is completely negligible when using good tape.

General Arrangement of Recorder

Bearing in mind the points just mentioned, the only question which the constructor must decide is the model of deck to use. For all general purposes, with the noted exception of piano and church organ recordings, the level of speed variations in the B.S.R. "Monardeck" type TD2 was found to be entirely satisfactory, and this was the deck used by the writer in the prototype recorder. Those interested in obtaining exceptionally good piano and church organ recordings, which are found to show up even the slightest "wow", or speed variation, would require a more expensive deck.

Having decided on the deck to be used, the other main points of the recorder may be decided.

In this unit, the internal loudspeaker was intended as a monitor only, and the fullest quality can only be expected when a good external speaker is used. Even so, very good results are obtained "as is" for general domestic use.

The complete recorder was to be housed in a small case, and be reasonably portable as a complete unit. The prototype weighed 18lb complete.

Amplifier Circuit

Provision has been made in the amplifier for the usual connection points and facilities. Briefly, these are:

1. Inputs for microphone, gram or radio.
2. Low level output for external amplifier when needed (also suitable for feeding a second recorder when re-recording).
3. Use of the amplifier for radio, gram or microphone, without using the tape facility.
4. Monitoring whilst recording, either via an external speaker or via the low level output socket and external amplifier.

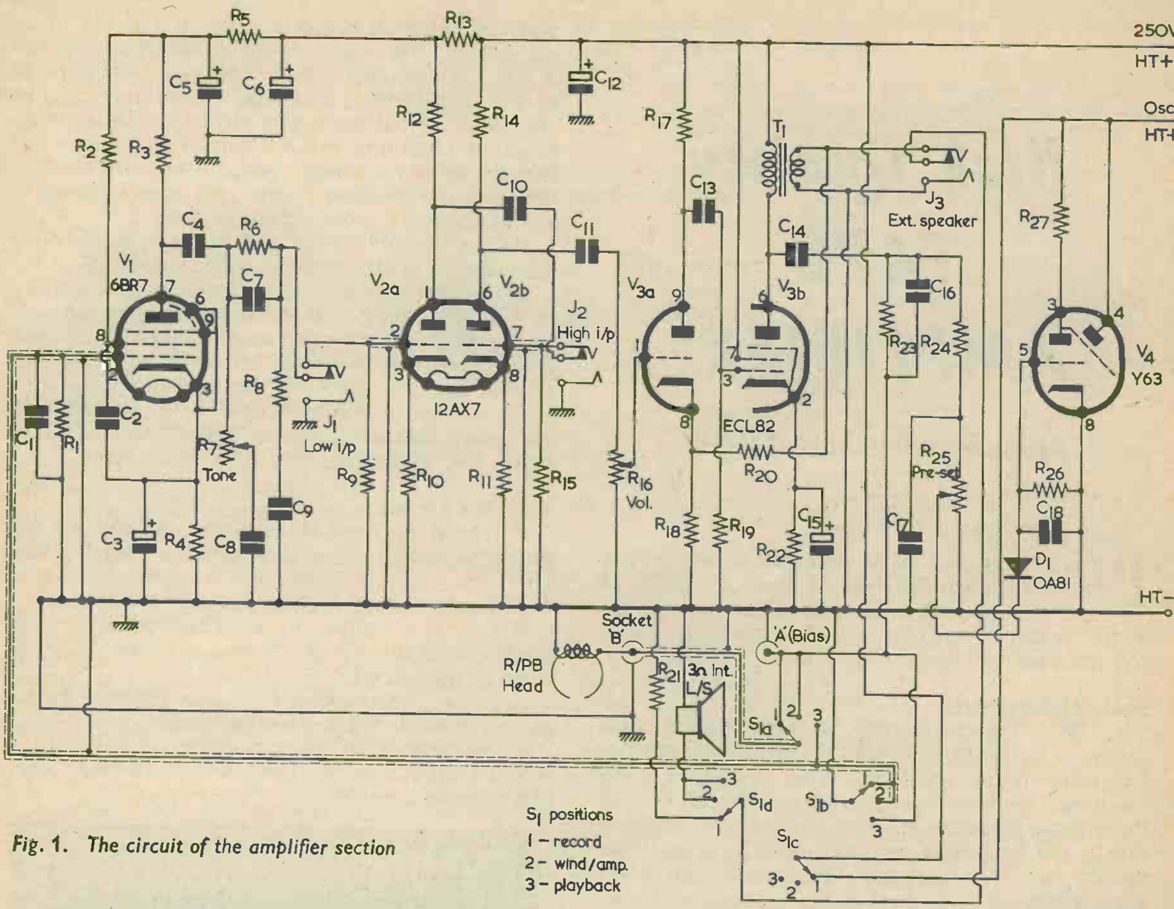


Fig. 1. The circuit of the amplifier section

5. Automatic muting of the internal speaker when an external speaker is plugged in and, also, during recording. (The external speaker may still be used during recording, if desired.)

6. De-magnetising of the tape heads every time the amplifier is switched off the recording position. This is essential to avoid hiss in the final recording.

7. When recording, the amplifier gives excellent results with almost any good microphone, being sufficiently sensitive even for the best ribbon types (one millivolt sensitivity).

8. From the quality point of view, the use of twin track recording is recommended, but the final decision is left to the constructor, as head switching is simple enough on the standard B.S.R. 4-track model, and will not affect the choice of circuit in any way. The prototype employed the 2-track model.

These points considered, we may now discuss the main amplifier circuit and construction.

The Main Amplifier Chassis

The main amplifier chassis houses all the amplifying stages, and is built in the normal box form, enabling the controls to be grouped conveniently at the front of the deck. The circuit diagram is given in Fig. 1,

The first stage employs a low noise pentode type 6BR7. This is the most critical stage of the amplifier, and has been designed to take no more current in the anode circuit than is needed to provide the required amount of low distortion signal for the following stage. This ensures that the high stability resistor in the anode circuit is given the best chance to live up to its name.

The first stage is only used during playback, and its grid is earthed during recording to avoid any possibility of unwanted signals reaching the recording circuit. Its output is also disconnected from the following stage by the insertion of the microphone plug in its socket.

To make the frequency response of the system as level as possible, a tone equalisation circuit is included between the output of the first stage and the input of the second. This circuit allows for a large amount of bass lift, and also a small amount of treble lift at the extreme upper end of the range, this being needed to correct for the losses which normally occur in a tape recording system. Inserting the tone correction circuit in this position in the amplifier ensures that it is automatically disconnected during the recording process, the small amount of correction needed for recording being

Components List
(Fig. 1)

Resistors
(All fixed resistors ½ watt 10% unless otherwise specified)

R_1 2MΩ
R_2 390kΩ
R_3 100kΩ high stability
R_4 1kΩ
R_5 150kΩ
R_6 100kΩ
R_7 500kΩ potentiometer, linear track
R_8 27kΩ
R_9 2MΩ
R_{10} 2.2kΩ
R_{11} 1kΩ
R_{12} 220kΩ
R_{13} 33kΩ
R_{14} 100kΩ
R_{15} 1MΩ
R_{16} 500kΩ potentiometer, log track
R_{17} 100kΩ
R_{18} 1kΩ
R_{19} 680kΩ
R_{20} 5.6kΩ
R_{21} 3Ω 2 watt
R_{22} 470Ω
R_{23} 68kΩ
R_{24} 47kΩ
R_{25} 500kΩ potentiometer, linear track, pre-set
R_{26} 10MΩ
R_{27} 1MΩ

Capacitors

C_1 330pF ceramic or silver-mica
C_2 0.1μF paper
C_3 50μF electrolytic, 6V wkg.
C_4 0.1μF paper
C_5 8μF electrolytic, 350V wkg.*
C_6 8μF electrolytic, 350V wkg.*
C_7 500pF ceramic or silver-mica
C_8 0.002μF paper
C_9 0.02μF paper
C_{10} 0.05μF paper
C_{11} 0.05μF paper
C_{12} 16μF electrolytic, 350V wkg.
C_{13} 0.1μF paper
C_{14} 0.1μF paper
C_{15} 50μF electrolytic, 25V wkg
C_{16} 500pF ceramic or silver-mica
C_{17} 500pF ceramic or silver-mica
C_{18} 0.1μF paper

Valves

V_1 6BR7
V_2 12AX7
V_3 ECL82
V_4 Y63

Diode

D_1 OA81

Switches

S_1 4-pole 3-way (Record—Wind/Amp—Playback)

Sockets and Plugs

$J_{1, 2, 3}$ Jacks with break contact
Sockets A, B Coaxial sockets
Jack plugs and coaxial plugs to suit above
3 B9A valve holders
1 Octal valve holder

Transformer

T_1 Speaker transformer, 45:1 or 50:1, 60mA primary, 3 watts

Record/Playback/Head

See text. Prototype used head fitted to B.S.R. "Monarch" TD2 twin-track deck

Speaker

7 x 4in 3Ω loudspeaker

* In single can

provided at a later stage in the amplifier.

The second stage consists of one-half of a double-triode type 12AX7. Once again, this must be regarded as a fairly critical stage, as it is the first stage of the amplifier when recording from low level signals, such as are given by microphones. Otherwise, the stage has a very straightforward circuit, and calls for no special comment. During playback, it is the second stage of the amplifier. Due to the use of a 2MΩ grid leak, the recorder may be used with crystal microphones of almost all types, in addition to other microphones with high impedance outputs.

The third stage is the other half of the 12AX7, and it provides additional amplification both on record and playback. During recording, when using the high level input socket, the signal is fed to its grid, the plug again disconnecting the previous stages in the interest of lowest noise level. The output of the third stage is passed to the volume control, which is thus in a position to control the gain on both recording and playback.

It will be noted that no cathode bypass capacitors are employed with the 12AX7. This results in considerable negative feedback, and quality improves. If a microphone with a very low output is used, the gain may be increased to suit by decoupling the first cathode with a 25μF capacitor, but the prototype gives sufficient gain for a Reslo ribbon microphone (with transformer step up) without the necessity for bypassing either cathode of the 12AX7.

The Fourth Stage

Following the volume control, there, are strictly speaking, two stages, but as they are so closely allied to each other we will consider them as a

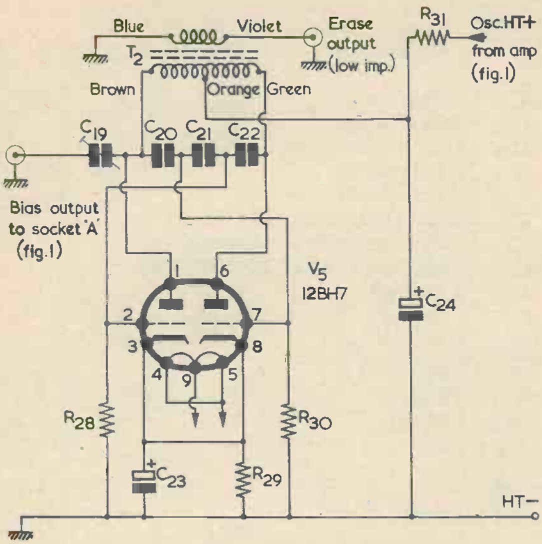


Fig. 2. The bias/erase oscillator circuit

single stage for our purpose. This may be even more acceptable when we see that the fourth "stage" consists of an ECL82 dual valve.

The needs for the fourth stage are quite different, depending on whether the unit is being used for replaying or recording a tape.

On playback the ECL82 acts as a high quality output stage capable of about 3 watts of high fidelity output to a 3 ohm speaker, which may be either external or internal. Heavy negative feedback is employed to reduce the distortion to a very low level, and particular care has been taken to see that the output is correctly matched to the loudspeaker load. This is most important, as the same circuit is used during recording to supply the actual recording signal to the head, and any distortion produced in the output would also be recorded.

When recording, the ECL82 stage is the last part of the recording amplifier, and it feeds the recording head via a suitable network, part of the signal also being used for the recording level indicator. Whilst in use for this purpose, a loudspeaker may be used to monitor the programme by way of the external speaker socket. Plugging in the external speaker overrides the automatic muting which is applied to the internal speaker during recording, and the external unit will function normally. The limitations to this method of monitoring are that it may not be used during recording via the microphone because of feedback, and the volume level must still be set to suit the recording process. The design is such, however, that a comfortable speaker volume is then produced. The components in the recording network have been chosen to give the necessary treble boost during recording, and they have no effect whatever on the reproduction from the speaker.

The function switch has three positions: Record,

Components List
(Fig. 2)

Resistors

(All resistors ½ watt 10% unless otherwise specified)

R_{28}	47kΩ
R_{29}	1kΩ 1 watt
R_{30}	47kΩ
R_{31}	100Ω 1 watt

Capacitors

C_{19}	300pF compression trimmer
C_{20}	0.005μF mica 350V wkg.
C_{21}	0.005μF mica 350V wkg.
C_{22}	0.005μF mica 350V wkg.
C_{23}	2μF electrolytic 150V wkg.
C_{24}	8μF electrolytic 350V wkg.

Valve

V_5 12BH7

Sockets and Plugs

2 coaxial sockets and plugs
1 B9A valve holder

Transformer

T_2 Push-pull bias/erase oscillator transformer type WF1388 (Mullard). Available from Home Radio (Mitcham) Ltd., under Cat. No. PAT85B

Wind/Amp and Playback. It will be noted that the record/playback head is still connected in circuit when Wind/Amp is selected. This connection is necessary as it ensures that the head is demagnetised by a slowly dying signal from the oscillator. Otherwise, the sudden breaking of the bias signal when switching from Record could magnetise the head, causing noise and distortion on the recorded tape.

Tone Control

After the care taken in the first stages of the amplifier to obtain a level frequency response, very little additional tone correction will be found necessary. A simple type of treble cut control has been included for use when desired, but even this, in the writer's unit, is usually at the level response position. On the other hand, it will quite often be found desirable to employ additional tone controls when recording from a pick-up, etc., and a circuit which has been found very useful is shown in Fig. 5. This is a circuit employed in the Mullard series of pre-amplifiers. It is built up into a unit which is independent of the main recorder, whereupon it forms a very handy accessory when recording from records or any source where bass or treble lift or cut is desirable.

The tone control may be fitted in a small case, say 6 x 2 x 2in, and its output is taken to the microphone input of the recorder to make up for the loss of signal which occurs in the control circuit. With the recorder gain set at about mid-position, the auxiliary volume control may be used to avoid overloading when working from large inputs, such as would be given by a crystal pick-up.

The Recording Level Indicator

The type of indicator employed is the tuning indicator type Y63. This is very satisfactory in use, gives a better response to fast signals than a meter could provide and does not require an expensive circuit. It is fed from a diode, which rectifies a portion of the output signal to feed d.c. to the control electrode. A pre-set control, R_{25}, is provided to set the indicator deflection to a suitable sensitivity.

The Bias Oscillator

To obtain the lowest background noise on the recorded tape, a good bias waveform is required, and it is produced here by the use of a push-pull oscillator incorporating a 12BH7 valve. (See Fig. 2.) The low impedance secondary of the coil is used to supply the erase head, and the bias is obtained via capacitor C_{19} from one anode of the oscillator. The oscillator frequency is approximately 50 kc/s.

To obtain the best frequency response from the complete equipment, some means of adjusting the bias voltage at the recording head is needed, and this is provided by C_{19}.

Construction—The Main Amplifying Stages

The most essential requirement with the main amplifying stages is to use a busbar type of earth lead to which all earthing points in the circuit are taken. The busbar is connected to chassis at one point only, this being at the tape head input socket. The general layout of the main components may be judged from Figs. 4 and 6.

The metal case of the capacitors C_5, C_6 and C_{12} is not connected to the chassis, it being insulated with suitable taping at the mounting clip. The case is then earthed by a lead to the busbar. This practice avoids the multiple earth paths which so often result in hum. The busbar is shown in Fig. 1 in heavy line, and the various components should be connected to it as nearly as possible in the same sequence as occurs in the circuit. In connecting the power supply to the main amplifier chassis, the only earth connection should be made via the h.t. negative lead to the end of the busbar remote from the input end of the amplifier. No other connection should be made to the chassis of the power supply as the possibility of earth "loops" causing hum is then considerable. There is no actual connection between the heater supplies and the chassis of the main amplifier, this being made, in the power supply unit, to the negative h.t. lead. The heater wiring in the amplifier should be twisted and laid close to the chassis.

Screened wire is employed in some parts of the circuit as indicated in Fig. 1. In Fig. 6 the upper and lower sides of the chassis are shown opened out flat, and this diagram illustrates the wiring layout around the record/playback switch. The leads from the recording amplifier output and those in the loudspeaker circuit should be laid as close to the chassis as possible, and away from other components in the amplifier. One end of each screened lead in the amplifier (apart from those illustrated in Fig. 6) is earthed to the busbar at *one point only* along its length, and is not allowed to touch the chassis elsewhere. It is relatively unimportant which end of a screened lead is earthed. In the prototype, coaxial cable of good quality was used for the screened leads.

Components List
(Fig. 3)

Resistors

R_{32} 100Ω 10% ½ watt
R_{33} 100Ω 10% ½ watt
R_{34} 30Ω 20% 5 watts
R_{35} 350Ω 20% 3 watts

Capacitors

C_{25} 100μF 350V wkg. electrolytic
C_{26} 200μF 350V wkg. electrolytic

Valve

V_6 EZ80

Switch

S_2 2-pole 1-way mains on-off

Socket

1 B9A valve base

Transformer

T_3 Mains transformer, fully shrouded, upright mounting. Primary: 200/220/240 volts. Secondaries: 250–0–250 volts at 60mA; 6.3 volts at 2.5 amps (minimum); 6.3 volts at 0.6 amps (minimum). Note: V_6 heater could run from a common 6.3 volt 3 amp secondary with V_1 to V_5

Fuses

1 1 amp fuse and holder
1 250mA fuse and holder

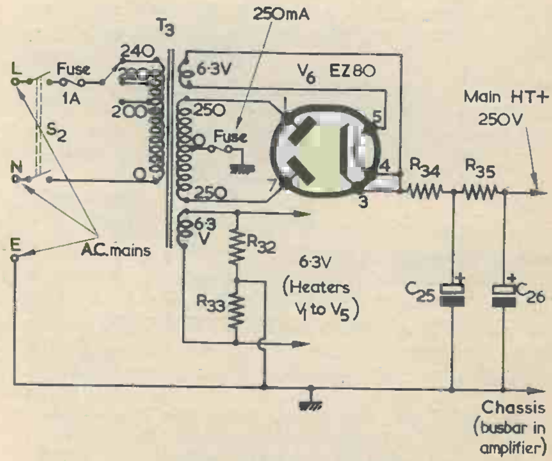


Fig. 3. The power supply

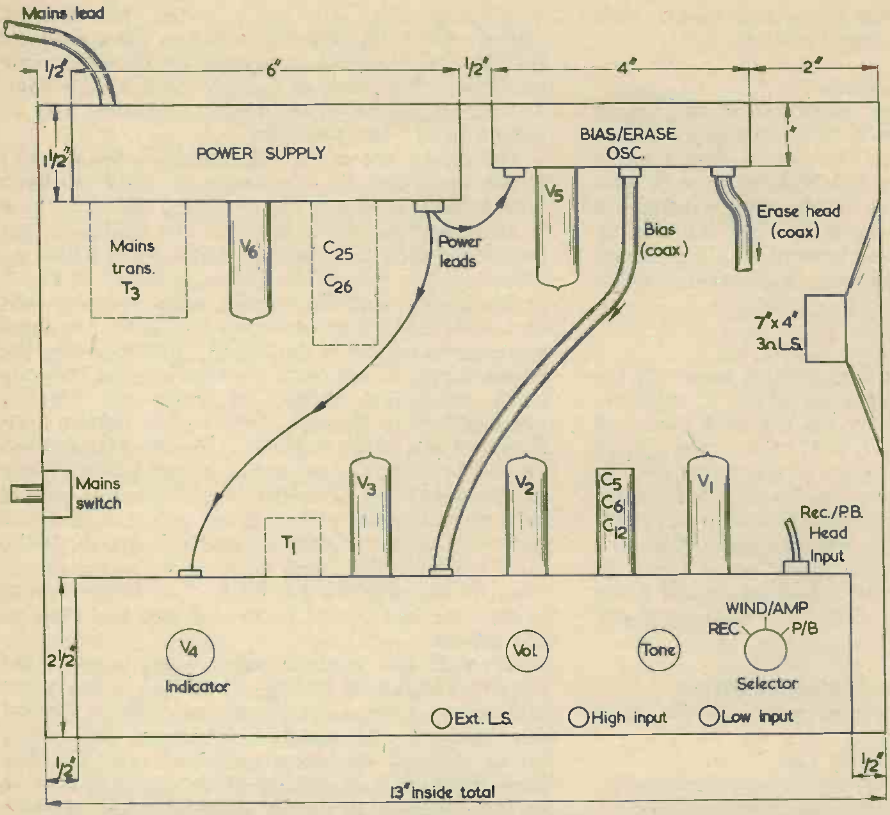


Fig. 4. The three chassis fitted inside the case. The dimensions shown are internal and may require modification for varying components

It should be added that, since the circuit uses a separate pre-amplifier stage (V_1) for playback, wiring to the switch is far less critical then with many other circuits. Feedback is caused by close coupling between the input and output circuits. The recording output is earthed during playback, and the grid of V_1 is earthed during Record or when the amplifier function is selected.

When completed, a metal bottom and metal end-covers should be fitted to the amplifier chassis to ensure complete screening.

Oscillator Construction

The r.f. signal generated by the bias oscillator has a nasty habit, if no care is taken, of leaking into other circuits of the main amplifier, with often

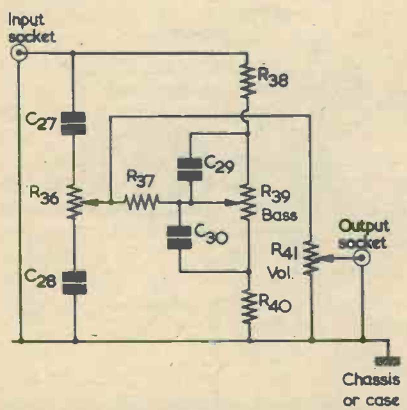


Fig. 5. A tone control unit which may be employed externally. It forms a handy accessory for recording from records or from any source where bass or treble lift or cut is desirable

Components List
(Fig. 5)

Resistors

R_{36} 250kΩ potentiometer, log track
R_{37} 39kΩ 10% ½ watt
R_{38} 68kΩ 10% ½ watt
R_{39} 250kΩ potentiometer, log track
R_{40} 6.8kΩ 10% ½ watt
R_{41} 250kΩ potentiometer, log track

Capacitors

C_{27} 560pF silvermica or ceramic
C_{28} 8,200pF silver mica or ceramic
C_{29} 0.002µF paper
C_{30} 0.02µF paper

Sockets and Plugs

2 coaxial sockets and plugs

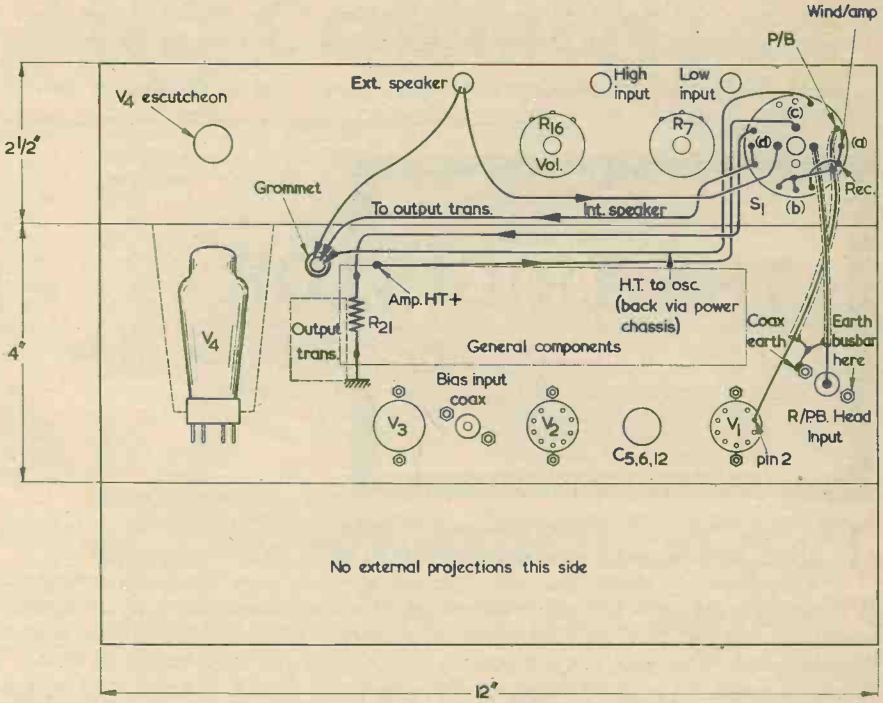


Fig. 6. Details of the wiring to switch S_1. The top and bottom of the chassis are shown opened out for ease of presentation. The lead from R_{23}/C_{16} to the switch is not shown here

unusual results in respect of amplifier performance. For this reason, the bias oscillator is constructed on a small chassis, separate from the main unit, and connected to the appropriate points by screened leads.

The small chassis is then mounted at the rear of the cabinet, away from the main amplifier chassis.

The Power Supply

The main enemy of tape heads and amplifiers, namely the mains transformer and smoothing circuit with its stray magnetic fields, is also mounted on a small chassis, this being again situated at the rear of the cabinet. Fig. 3 shows the power supply circuit.

To keep hum on the h.t. line down to a very low level, smoothing is carried out by a TV type of twin capacitor having a value of 100+200μF. This gives a very quiet background, even though the usual smoothing choke is replaced by a resistor. This last point also has the advantage of removing another source of stray magnetic fields from the construction. A transformer giving 250–0–250 volts is quite adequate, and does not strain the 350 volt reservoir and smoothing capacitors unduly.

General Layout

The general layout inside the case is shown in Fig. 4. The depth of the case is 4½in, the tape deck being mounted on a wooden panel at the surface. The depth of the power supply and amplifier chassis is 4in, and that of the oscillator chassis 3in. The general layout shown should enable electronic components to clear the underside of the deck, and this point should be checked in individual units owing to possible variations in component size.

To prevent the formation of hum loops in the supply wiring, the h.t. negative supply from the power unit connects to the main amplifier chassis only. This supply is then carried to the oscillator chassis via the outer conductor of the screened cable carrying the bias voltage. Thus, the bias cable between the two chassis *must* be connected before the oscillator receives h.t. There is no other earth connection to the oscillator chassis. As may be gathered from Fig. 6, the h.t. positive supply to the oscillator chassis is routed back via the power supply chassis.

The deck is earthed by a single lead to the power supply chassis. Care must be taken to ensure that no connection exists between any of the head leads, or their screening, and the tape deck.

Setting Up

With the main selector switch set to the amplifier position, the unit may be tested as any normal audio amplifier. When satisfactory, it should be switched to Record, and a test recording made. This is then played back by rewinding and switching to Playback. There should be no setting up required in the Playback position, so this may be taken to give a good guide as to the recorded quality.

In setting up the bias control, the point should be chosen where quality is least distorted. If too much bias is used, the signal will be short of treble, whilst if insufficient is used, distortion will be evident. Bias is increased by screwing in the compression trimmer C_{19}, and reduced by screwing it out.

With practice, the optimum amount of gain, and the deflection it gives on the indicator, will soon be found. By adjustment of the pre-set control in the indicator circuit, a convenient deflection may then be set for the full modulation level.

THE TRIGISTOR

By J. B. Dance, M.Sc.

THE TRIGISTOR IS A THREE TERMINAL P.N.P.N. silicon semiconductor device manufactured by Solid State Products Inc. of Massachusetts. It is basically the same type of device as the silicon controlled rectifier, but has been primarily designed for use in logic and multivibrator circuits where the power is small. The functioning of the Trigistor will not be discussed in detail since it is similar to that of the silicon controlled rectifier, the operation of which was described in "The Silicon Controlled Rectifier" by M. J. Darby (*The Radio Constructor*, September 1962, page 93).

The Trigistor is normally in its non-conducting or high impedance state, but when a positive-going pulse is applied to its trigger electrode the device conducts. The Trigistor returns to its high resistance state when the current passing through it falls sufficiently or when a negative-going pulse is applied to the trigger electrode.

The two characteristic stable states possessed by this device make it ideal for use in multivibrator circuits. The simplification which can be achieved by the use of a Trigistor instead of the conventional transistor multivibrator circuit is apparent from Figs. 1 and 2. This simplification is possible because the Trigistor, like the silicon controlled rectifier, is effectively two transistors in one unit. Simplification of circuitry tends to bring the added advantage of increased reliability.

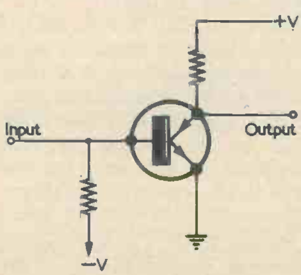


Fig. 1. The basic Trigistor bistable circuit

In the conducting state, currently manufactured Trigistors pass a current ranging from about 1 to 8mA, the voltage drop from the collector to the emitter being less than 1 volt. The dynamic resistance is about 10Ω in the conducting state. In the high resistance state the Trigistor leakage current is normally less than 1μA. Repetition rates of up to about 200 kc/s can be attained with the present series of Trigistors, but the manufacturers expect this frequency to be raised to at least 1 Mc/s as new types are developed.

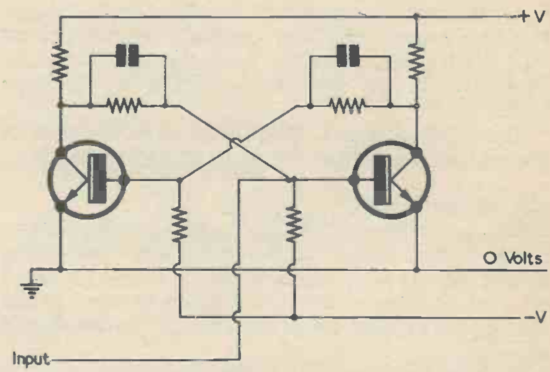


Fig. 2. The conventional transistor bistable circuit

The use of Trigistors in various types of multivibrator circuits, memory circuits, shift registers, ring and binary counting circuits is discussed in the publication *A Survey of Some Basic Trigistor Circuits* (3C Series of Silicon Trigistors), which is available from the manufacturers, Solid State Products Incorporated, 1 Pingree Street, Salem, Massachusetts, U.S.A. This publication is Bulletin No. D410–02, 3–60.

NEWS AND COMMENT . .

B.B.C. 2

We shall soon know whether B.B.C. 2 is to be a true alternative to B.B.C. 1, and whether we shall escape from the tyranny of two competing systems competing for the same audience at the same time.

The programmes are certainly not going to be all of the Third Programme variety as the following details of future broadcasts show.

On Saturday afternoons there will be a two-hour live magazine from 4 p.m. to 6 p.m., introduced by Gay Byrne, as an alternative to sport. Saturday evenings will have "International Cabaret", produced and directed by Buddy Bregman, with the top-line artist being given a twenty to twenty-five minute spot. Heading the list in the first show is Shirley Bassey. Other top-liners signed include Roy Castle, Anna Maria Alberghetti, Gordon and Sheila Macrea, Mel Torme, Margaret Whiting and Juliet Prowse. Altogether fourteen programmes are ready in outline.

On Sundays there is a musical show, "The Best of Both Worlds", presenting the world's leading composer-arrangers. So far they include Mantovani, David Rose, Robert Farnon, Nelson Riddle, Stanley Black, Andre Previn, Percy Faith and Frank Chacksfield.

Monday has a new-style comedy show which has no script, but with *ad lib.* sketches and material prompted by the audience. The producer, David Croft, explains that the idea is an extension—in light entertainment terms—of exercises carried out in drama school. Those taking part include Lance Percival, Victor Spinetti, Peter Reeves, Jeremy Hawke and Anne Cunningham.

Jazz is being presented for the first time in a regular series on Tuesdays. Duke Ellington has recorded two programmes and other editions will feature Dave Brubeck, the Modern Jazz Quartette and Oscar Petersen. In addition there would be single shows from Tony Bennett, Allan Sherman and Arkady Raikin.

Pinhead Amplifier for Distant Light Signals

One of the newest aids to space communications is a tiny device, not much bigger than a pinhead, which is sensitive to extremely faint light and which can detect and amplify signals carried on as little as one-thousand millionth of a watt of light.

It was developed by David E. Sawyer of the Sperry Rand Research Centre and is called a photoparametric diode. It may eventually become the heart of a communications receiver unit no bigger than a matchbox, which could be used in space.

Mr. Sawyer says that more advanced models of the device may be able to detect and amplify a signal carried through space of only one trillionth of a watt of light. (A trillion is the numeral one followed by 18 zeros.) Detecting such an infinitesimal amount of light is roughly comparable to someone on the moon being able to see the glow from a single 400-watt bulb in a lamp on earth.

Pictures That Make Figures

Specialised electronic equipment that can convert graphs, maps and engineering drawings into digital information in the form required for a computer is made by Benson-Lehner, a firm that has broken new ground in feeding graphics into a computer and getting graphics out. The "picture" to be studied is electronically scanned and automatically converted into a series of mathematical points which feed directly into the computer. The reverse process is to accept digital data from a computer and convert it into graphical form. . Weather charts, traffic surveys, PERT critical path analyses and machine tool control data are among the applications to which the plotters can be put.

The company calls its equipment "the eyes and hands of the computer".

Road Safety

The ingenuity with which advances in electronics are applied to various activities is a fascinating study. We recently learned of a new use for closed-circuit television. American scientists are studying the cause of highway accidents with a driving simulator.

A saloon car is part of the simulator but it does not move. Instead, a screen in front of the windscreen gives the driver views he would normally see from a car in motion.

The illusion of driving is created by a closed-circuit television system set up on the model of a landscape, over which the TV camera moves in accordance with the way the driver steers the car.

The model landscape contains miniature houses, telegraph poles, various types of road lines, curbs, moving and stationary cars and pedestrians, all of which appear to the driver in life size on the screen. To add realism, an engine-sound generator under the bonnet duplicates the sounds made by a moving car.

Throughout his manoeuvres the driver's actions and reactions are watched from a monitoring console.

The device simulates normal driving conditions at speeds up to 70 miles an hour and can give the illusion of driving at dusk and at night, as well as in sunlight.

The simulator was designed by the Goodyear Aerospace Corporation of Akron, Ohio.

Shakespeare and The Radio Amateur

St. George's Day, 23rd April, 1964, will mark the 400th Anniversary of William Shakespeare's birth and will be celebrated throughout the world, particularly at Stratford-upon-Avon, where there will be a Festival of commemorative activities extending from April to September.

The Stratford-upon-Avon and District Radio Club will be operating an amateur radio station.

The station will be in Henley Street overlooking Shakespeare's birthplace and the call sign will be GB2WS. The public will not be allowed in the station but they will be able to see and, most probably, hear what is going on.

A special request was made to the Postmaster-General for the use of the call sign GB2WS and the club is most grateful that permission was granted.

A unique QSL card has been compiled for this occasion which will depict a photograph of the poet's birthplace and the motif specially designed for this Festival.

Leading radio manufacturers have lent their equipment to set up this station. We hope their kind co-operation will bring much pleasure to those amateurs in many parts of the world who will be unable to go to Stratford-upon-Avon.

The festivities start on 22nd April with the opening of the new Shakespeare Centre, so it is hoped that Station GB2WS will go on the air that evening about 17.00 hours G.M.T. It will continue on 23rd, 24th and 25th April from 08.00 to 17.00 hours G.M.T. on the 20, 40 and 80 metre bands.

All contacts will be acknowledged by QSL through the R.S.G.B. Bureau.

The thirty-second in a series of articles which, starting from first principles, describes the basic theory and practice of radio

part 32

understanding radio

By W. G. MORLEY

In last month's article in this series we continued our discussion on sound reproduction, dealing in detail with the magnetic diaphragm earphone. We shall now carry on to the loudspeaker.

The Moving-Coil Loudspeaker

The *loudspeaker*, or *speaker*, is a very familiar device, and its function is to reproduce, as sound, the electrical signals fed to it. There are a number of different types of loudspeaker, but one of these, the *moving-coil loudspeaker*, is employed very much more frequently than any of the others. We shall, in consequence, commence by dealing with this type of loudspeaker.[1]

To understand the functioning of the moving-coil loudspeaker we have, first of all, to return to the basic relationships between electric current and magnetic flux which we examined in Part 12 of this series.[2] At that time we saw that, if a current is passed through a straight conductor, a circular magnetic field appears around it. This may be demonstrated by the situation illustrated in Fig. 205 (*a*), which shows some of the lines of magnetic force about the conductor. The direction of magnetic lines of force is from north pole to south pole, and the individual lines are provided with arrows which indicate that direction. In Fig. 205 (*a*), the upper end of the conductor is connected to the positive terminal of the source of e.m.f. which causes the current to flow, the lower end being connected to the negative terminal. For our present discussion, it will be helpful to view the conductor end-on, as in Fig. 205 (*b*), it being assumed here that the conductor passes at right angles through the paper on which the diagram is printed. The positive end of the conductor (the upper end in Fig. 205 (*a*)) is now towards us, and we indicate this fact by putting a + sign at the end. The circular field is then that which appears in the plane of the paper, and it will be noted that the direction of the lines of force is clockwise. Fig. 205 (*c*) shows what occurs if we re-draw Fig. 205 (*a*) in the same manner, but with the negative end of the conductor towards us. We indicate that this is the negative end by putting a dot in the centre of the circle which represents the end-on view of the conductor. Once more we obtain our circular magnetic field, but the direction of the lines of force is now in the opposite direction, i.e. anti-clockwise.

In Fig. 206 (*a*) we see a horseshoe magnet together with the lines of force which appear immediately between its two poles. The direction of these lines of force is, as indicated, from north pole to south pole. In Fig. 206 (*b*) we introduce the conductor of Fig. 205 (*a*) between the poles of the magnet and with the positive end towards us, whilst in Fig. 206 (*c*) we show the same state of affairs with the conductor drawn end-on. We also add the circular magnetic field around the conductor.

If we now examine Fig. 206 (*c*) we will note that, to the right of the conductor, the circular lines of magnetic force are in the same direction as those due to the permanent magnet whilst, to the left of the conductor, they are in the opposite direction. As a result, the strength of the magnetic field to the right of the conductor becomes increased, because the field from the conductor augments that from the permanent magnet. At the same time, the strength of the magnetic field to the left of the conductor becomes weaker, since the lines of force in opposite directions cancel each other out. The result is that the composite field takes up the appearance shown in Fig. 206 (*d*).

[1] The moving-coil loudspeaker is also referred to, particularly in American literature, as the *dynamic loudspeaker* or, sometimes, the *electro-dynamic loudspeaker*.

[2] "Understanding Radio", part 12, August 1962 issue.

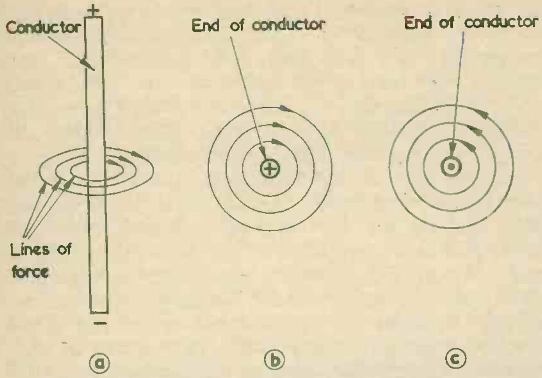


Fig. 205 (a). When a current is caused to flow through a conductor, circular lines of magnetic force appear around it, as shown here
(b). In this diagram the conductor of (a) is viewed end-on, with the positive end towards the reader. The field has a clockwise direction
(c). If the negative end of the conductor is viewed end-on, the field has an anti-clockwise direction

The lines of force in Fig. 206 (*d*) are considerably different from those shown in Fig. 206 (*a*) because they are distorted out of their natural shape. In consequence they exert, upon the conductor, a force which will allow them to revert to their original condition. (Another way of stating this is to say that lines of magnetic force tend to follow the shortest path and that, if they have the same direction, they repel each other. The lines of force to the right of the conductor are longer and more compressed than those to the left of the conductor, and they exert a force to the left in consequence.)

If the conductor is free to move it will then be shifted to the left, as indicated in Fig. 206 (*e*). However, since it remains in the magnetic field due to the permanent magnet the same conditions as exist in Fig. 206 (*d*) will still apply; and it will continue to be shifted to the left until it has passed to a point on the outside edge of the magnet field where field strength is negligible. If, on the other hand, the conductor is held in position by a restraining force, such as would be given by a spring, it will suffer displacement to the point at which the restraining force offered by the spring becomes equal to the force resulting from the interaction of the two magnetic fields. This displacement will increase if the strength of the magnetic field about the conductor increases, due to increased current flow through it. The displacement will also increase if the strength of the field due to the permanent magnet increases (as would occur, for instance, if the magnet were replaced by a more powerful one).

When the current flowing in the conductor is reversed in direction, as in Fig. 206 (*f*) where the negative end is towards us, the field around the conductor becomes anti-clockwise. This then augments the permanent magnet field on the left hand side of the conductor, and reduces the field to the right of the conductor. The conductor then suffers a force moving it to the right.

By employing similar reasoning it may also be seen that the force applied to the conductor reverses in direction if the permanent magnet field is reversed. If, therefore, the permanent magnet of Fig. 206 (*d*) is turned over so that its north pole is below the conductor and the south pole above, the conductor will suffer a force moving it to the right instead of to the left. Similarly, if the permanent magnet poles of Fig. 206 (*f*) are reversed, the conductor will suffer a force moving it to the left instead of to the right.

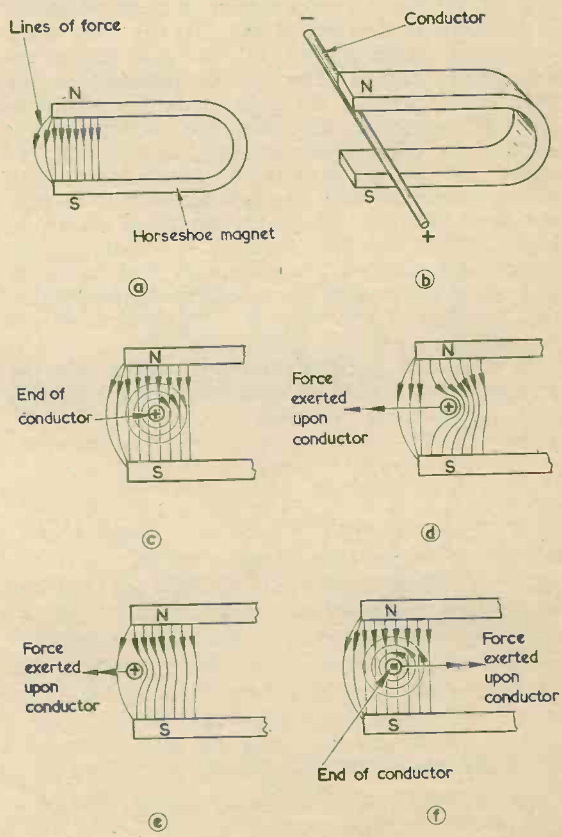


Fig. 206 (a). The lines of force immediately between the poles of a horseshoe magnet
(b). Introducing a straight conductor, with positive end towards the reader, between the poles of the magnet
(c). The lines of force about the conductor of (b) together with those due to the permanent magnet
(d). The combination of the two fields causes a force to be exerted on the conductor, moving it to the left
(e). Even after the conductor has shifted to the left, it is still in the field of the magnet, and it is still subject to the force
(f). If the negative end of the conductor is towards the reader, the interaction of magnetic fields causes it to suffer a force moving it to the right

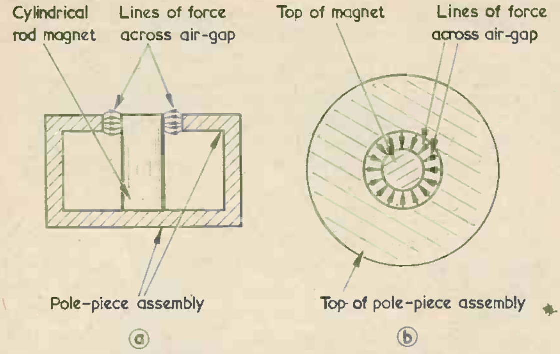


Fig. 207 (a). Cross-sectional view through a typical magnet and pole-piece assembly for a moving-coil loudspeaker. It is assumed here that the upper end of the cylindrical magnet has a south pole
(b). As may be gathered from this top view, the pole-piece assembly completely encloses the magnet, leaving only a circular air-gap

In a moving-coil loudspeaker, the magnet employed may take up the appearance illustrated in Figs. 207 (*a*) and (*b*). In these diagrams we have a cylindrical rod magnet having a pole at either end. The lower end of the magnet is fitted to a soft-iron pole-piece assembly which completely encloses it except for a small circular air-gap at the top end. Fig. 207 (*a*) shows a cross-section through the centre of the construction whilst Fig. 207 (*b*) gives a top view showing the air-gap and the upper end of the cylindrical magnet. Due to the presence of the pole-piece assembly, the pole at the lower end of the rod magnet is now effectively shifted until it appears in the pole-piece metal surrounding the upper end of the rod magnet. In consequence, a strong magnetic field appears across the air-gap, the lines of force taking up the form shown in Figs. 207 (*a*) and (*b*). In these two diagrams we assume, for purposes of explanation, that the upper end of the bar magnet has a south pole, whereupon the direction of the lines of force is towards the magnet.

In Figs. 208 (*a*) and (*b*) we introduce into the air-gap a coil wound on a thin cylindrical former,

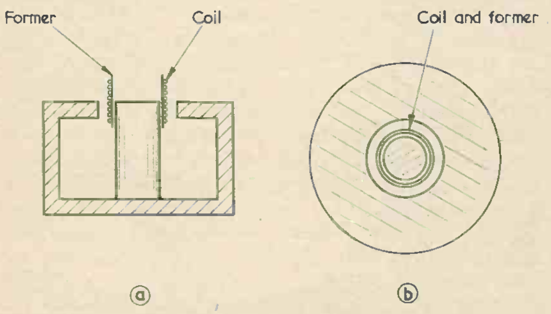


Fig. 208 (a). Introducing a coil and former into the air-gap
(b). Top view of the coil and former inside the air-gap

this being so mounted that it is free to move in and out of the assembly without touching either side of the air-gap. We then apply a source of e.m.f. such that the outer end of the coil is positive. The result is shown in Fig. 209 (*a*), wherein we have turned the assembly through 90° in order that it may be compared with Fig. 206. The situation existing in the upper part of the air-gap is, now, exactly the same as occurred in Fig. 206 (*d*), apart from the fact that, because we are employing a coil, we have more than one conductor in the permanent magnet field. As in Fig. 206 (*d*) the permanent magnet north pole is uppermost. Similarly, the current flowing through the conductors is in the same direction as occurred in Fig. 206 (*d*), and so we may put a + sign in their centres. Exactly as occurred in Fig. 206 (*d*) these conductors then suffer a displacement to the left.

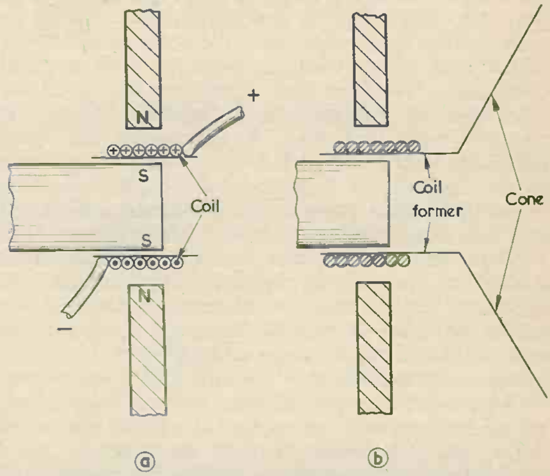


Fig. 209 (a). The effect of applying an e.m.f. with the polarity shown here causes the coil to move to the left. Reversing polarity causes it to move to the right
(b). The vibrations of the coil former may be made audible by coupling it to a cone

The current flowing in the coil conductors in the lower section of the air-gap of Fig. 209 (*a*) corresponds to a positive terminal below the paper (or a negative terminal above) whereupon we may place a dot in their centres, similar to that shown in Fig. 206 (*f*). In consequence the field about the conductors is now anti-clockwise. This does not result in these conductors moving to the right, however, because the permanent magnet field in this section of the air-gap (compared with that in the upper section) is *also* reversed. As a result, this section of the coil moves to the left as well.

The above description of operation applies to any cross-sectional view of the coil in the air-gap, and it may be summed up by saying that, under the conditions shown in Fig. 209 (*a*), all sections of the coil suffer a force causing them to move to the left.

If the current flowing through the coil is reversed, all sections of the coil will suffer a force moving them to the right.

We now have the basic requirements for a moving-coil loudspeaker and the next step consists of adding a *cone* to the coil former, as in Fig. 209 (*b*). This cone will then move to the left or right according to the direction of the current flowing through the coil. If we apply an electrical signal obtained from, say, a carbon microphone and transformer,[3] then the cone will move in sympathy with the compressions and rarefactions which impinged on the microphone diaphragm and will, in consequence, reproduce the original sound.

In Figs. 207 and 209 (*a*) we assumed that the centre pole of the magnet and pole-piece assembly was a south pole, since this assisted in the process of explanation. However, the polarity of the magnet is unimportant in practice, since the function of the loudspeaker is to reproduce an alternating quantity in frequency and amplitude. Reversal of magnet polarity merely results in the cone moving inwards where it would otherwise move outwards, and this does not affect the reproduction from a single loudspeaker. Whilst referring to this point, it should be mentioned that for certain applications employing more than one loudspeaker fed from a common signal, it is desirable that all the loudspeaker cones move inwards and outwards in unison (i.e. in phase). If for any reason the cone movement of one loudspeaker is out of phase, it may be brought into phase by the simple process of reversing the connections to its coil.

[3] See "Understanding Radio", part 30, February 1964 issue.

Next Month

In next month's article we shall continue to examine the moving-coil loudspeaker.

SIMPLE FREQUENCY COINCIDENCE INDICATOR

By J. R. Knight

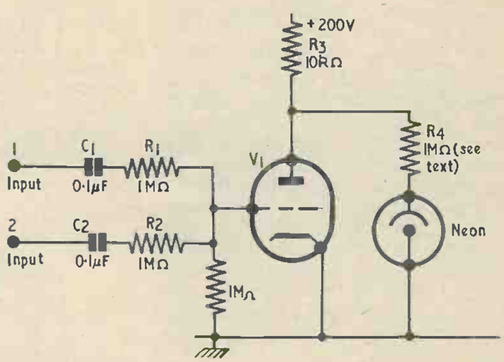
When calibrating a.f. oscillators, filters and similar equipment, it is often necessary to know when two alternating currents are of exactly equal frequency. This may be done by ear, listening for zero beat. However, the unit shown in the accompanying circuit diagram will not only provide this indication, but can also show when one frequency is an exact multiple of the other, up to ratios of about 10 to 1.

Operation

The frequencies to be compared are fed to the grid of V_1, which acts as a detector by drawing grid current on positive half-cycles. The difference frequency is applied to the neon, which then flashes in time with it. At zero beat, the neon remains either continually on or continually off.

In the prototype, which employed a 100 volt neon, R_4 was 1MΩ. The value of this resistor should be found by experiment, however, and it should be such that the neon is just below lighting up when no signal is applied to the grid of the valve.* A negative grid signal will then cause the neon to strike. Any small neon from 75 to 180 volts should be suitable.

* This requirement could be met by adjusting R_3 also.—Editor.



Valve Type

V_1 can be any small triode or pentode (e.g. 6J5, 6C4, EF91, etc.). A 6J5 was used in the prototype.

The complete unit was assembled on a small square of hardboard with the neon projecting through the panel. Screw terminals were provided for the inputs. The h.t. voltage should be 200, and the l.t. supply that which suits the valve. H.T. consumption with the prototype was 4mA. The a.f. input required is about 3 volts peak-to-peak and, as a refinement, input potentiometers could be fitted. The inputs must be of about equal amplitude.

ELECTRIC POWER CABLE TRACKER

By C. Morgan

WITH THE BEST INTENTIONS IN the world, coupled with an experience of house wiring for electric power and light, the writer set off to assist a friend who had recently moved into a "not-so-new" dwelling.

On arrival at the appointed place, an inspection was made to check the condition of the wiring and its insulation, and to see if it was possible to obtain at least some form of lighting for the occupants during the hours of darkness.

It was found that the insulation, fuses and switches were all in order, but that the previous tenant had no idea at all where the cables that supplied the power and light were positioned. These were set into the walls and floors in a manner that defied detection.

The haphazard cable layout had resulted because the structure of the house had been altered from time to time, and the wiring had been re-routed to comply with the requirements of the existing tenants. It was also found, after further inspection, that although some cables were connected to the supply they disappeared into the walls and were terminated with insulating tape. The original position of the plug or switch had been filled in flush to the wall so that the terminating point was impossible to find.

Observing that the new owner wanted to make several alterations in the structure of the walls, and that the possibility of short-circuiting some hidden mains supply wiring would not help, it was decided to build a tracking unit to find the elusive cables.

Construction of the Tracker

The tracker is constructed in two parts. The first part was required to inject into the cable some form of electrical signal, and the second part was required to pick up and track this signal along the length of the cable. The tracker also had to be capable of determining if and where a broken wire existed along the length of the wiring system.

The first part, the signal injector, includes a 4 or 6 volt electric bell with the gong removed, or a buzzer if this item is to hand. Also required are a 4 or 6 volt battery, and a spare speaker transformer in good condition. Any valve speaker transformer may be employed, and the circuit is in no way critical so long as all components are in good working order.

It will be seen in the circuit diagram of Fig. 1 that the positive terminal of the battery is connected to one terminal of the buzzer, this being in series with a winding on the speaker transformer and the switch. When the switch is closed, a circuit is completed to the buzzer via the transformer winding, whereupon the buzzer operates. The winding in the buzzer circuit is, for radio applications, the secondary of the transformer, and it is that which has the lower resistance. The higher resistance winding (the primary for radio applications) connects to the output terminals and, thence, to twin flex terminated in crocodile clips and having a length of several feet.

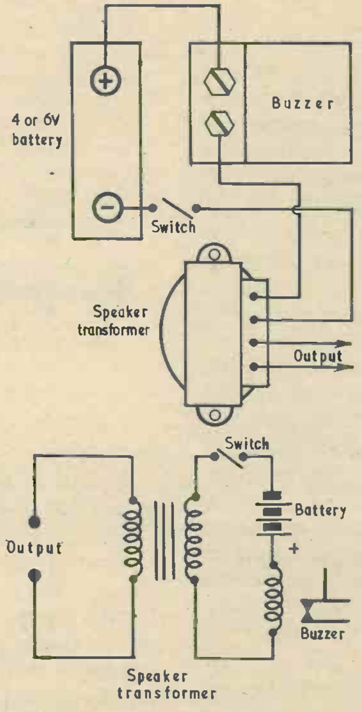


Fig. 1. The signal injector section of the cable tracker

If the battery and buzzer are in good order, the latter should start operating when the switch is closed. If this does not happen, the trouble may be due to the small resistance inserted by the transformer winding, and the buzzer armature adjusting screw will require resetting. If the buzzer still fails to operate after making this adjustment, it will probably be because the transformer is connected up the wrong way round, and the high resistance winding is in the buzzer circuit.

The output leads from the speaker transformer are connected to the fuse box after the fuses have been removed and the mains supply switch has been made safe.

The signal injector assembly can be made quite compact if the two main components and the battery are mounted inside a small wooden box. This makes for a neat appearance, and allows the buzzer to be muffled, a point which is of assistance when tracking is taking place in a position where both units are very close together.

The Pick-Up Unit

The second unit consists of a simple two stage transistorised amplifier, a personal earphone having a resistance of 200 to 500Ω, and a small low frequency smoothing choke. See Fig. 2.

The amplifier is simple enough to construct, and can be made up into a small wooden box about 4in long, 2in wide, and 1in deep. Four small terminals, two at each end of the box, will suffice for connecting the choke and the personal hearing aid in circuit.

It is strongly advised that a personal hearing aid phone be used for this unit. The writer has used a headphone of the same resistance, but the distinct advantage of the personal ear piece has to be tried to be believed. Not only is the personal ear piece smaller and,

Components List
(Fig. 2)

Resistors
(All resistors ¼ watt 10%)
R_1 100kΩ
R_2 1kΩ
R_3 6.8kΩ
R_4 6.8kΩ

Capacitors
(All capacitors electrolytic, 3V wkg.)
C_1 8μF
C_2 8μF
C_3 8μF

Transistors
TR_1 OC71
TR_2 OC72

Choke
Low frequency choke. See text

Earphone
Hearing aid earphone, 200 to 500Ω resistance

Switch
On-Off switch, s.p.s.t.

Battery
3 volt battery

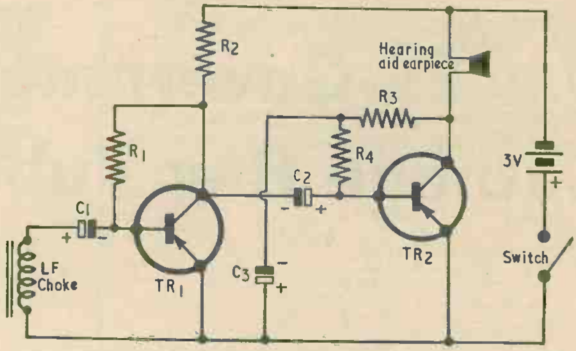


Fig. 2. The circuit of the pick up unit

therefore, more compact, but the gain in sound level is very remarkable.

The l.f. choke is connected to the input of the amplifier by a length of twisted flex, so that it may be orientated in awkward corners and confined spaces.

Tracking Procedure

There are several ways in which tracking of the hidden cable can be carried out. The first thing to do is to check that everything is working correctly. To do this, switch on the battery and buzzer, and ensure that the latter is operating.

Next, switch on the pick-up unit and bring the l.f. choke near to the buzzer or transformer. A very loud buzzing should be heard in the earphone, and this will indicate that everything is functioning properly.

Follow this by making certain that the operator of the tracker has pulled out all the fuses in the main fuse box, and that the main switch has been opened. If children are liable to tamper, the main switch should be secured in the off position with stout wire.

Connect, at the fuse box the output leads from the buzzer unit to the cable it is intended to trace. Next, place the tracker unit l.f. choke near the wall. It will be obvious, by rotating the choke, which direction the cable is going, since the signal will become fainter when the choke is moved away from the cable. Over half a mile of hidden cable has been tracked in this manner, so there is no fear that the signal will fade out in any house wiring.

It is possible that the signal will suddenly drop in signal strength at a switch. Should this be the case put the switch into the make position, and the signal will continue at its original strength. If, at any time, a loud and clear signal almost ceases, the fault can be due to one or two things. One of these is that the wire has broken in the wall; whilst the other is that the cable was previously terminated in a socket which has since been shifted.

It does not matter greatly whether the buzzer unit is clipped to power or light cables as long as a pair is selected. Interaction will take place along the cables and the buzzing will be heard on all wiring.

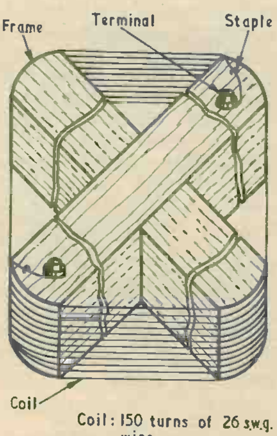


Fig. 3. A search coil for tracking underground cable

If one has no desire to disturb the mains fuses, another method of investigating the wiring is to first break the mains switch (and wire it into the off position if children are around) then clip the crocodile clips on to any convenient socket, light or power, and continue as before.

Underground Cable

It is also possible to track underground cable with this equipment, but with the proviso that both ends of the cable must be open circuited so that the signal can radiate at adequate strength. Short-circuited leads will impose a load on the transformer, and cause it to offer a reduced signal level.

The nature of the ground in which the cable is buried will have a very marked effect on the signal being heard via the amplifier. If the ground is dry and does not contain a lot of clay, a cable can be tracked at a depth of two to three feet. If the ground is of heavy clay, then poor results can be expected with the l.f. choke, and a different type of search coil will have to be made.

The alternative search coil is wound on two lengths of 1in x 1in x 2ft light timber joined at their centres to form a cross. The ends of the timber need to be slightly rounded and smooth. Two terminals mounted on the wood provide termination points for the 150 turns of 26 s.w.g. insulated wire required for the coil. See Fig. 3.

After the turns have been wound on, they can be given a protection in the form of insulation tape to prevent damage to the coil. This completed frame can then be used to track the cable in a manner similar to that employed in the Services to detect land mines.

Using Ex-Government Cathode Ray Tubes

By H. N. Rutt

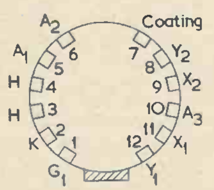
In this article, our contributor gives details concerning several ex-Government cathode ray tubes which are still currently available. Because of the difficulty of obtaining reliable information on these tubes, we do not necessarily guarantee the accuracy of the operating conditions or base connections quoted.—Editor

On the surplus market at the moment there are many types of ex-Government cathode ray tubes but it is, unfortunately, practically impossible to ascertain their base connections and working voltages. This article provides details on several ex-Government c.r.t's the author has used or about which he has obtained information.

The ACR13

The ACR13 has base connections as in Fig. 1, but it appears that the connections to the X and Y plates are not rigidly maintained—these vary from tube to tube, although they may easily be found by experiment.* The tube has a 4V 1A heater, but the heater-cathode insulation will *not* stand high voltages, as seems to be the case with all ex-Government tubes. Typical working conditions would be: coating strapped to A3 and A1, +190V; G, (brilliance), about −600V ±30V; cathode, −560V; A2 (focus), 300V. The tube is an equivalent to the VCR97, VCR138 and VCR138A, except in size. It measures 16½in long with a 5½in flat round screen and it produces a green display.

* This effect could possibly be due to varying orientation between the body of the tube and its base.—Editor.



Base= B12D
VCR97, VCR138,
VCR138A, ACR13

The VCR138 and VCR138A

The VCR138 and VCR138A appear to be identical, although the writer does not have the dimensions for the 138A. They work quite satisfactorily in the same circuit as the ACR13, but the focus control needs considerable readjustment.

The VCR138 measures 13¼in long by 2¼in (neck) and has a 3in flat round screen, having a green display It provides better focusing than the ACR13 which, in the author's circuits at least, gives a rather "fuzzy" trace. The base connections to the VCR138 and 138A are identical to those of the ARC13, although again the X and Y connections may vary.

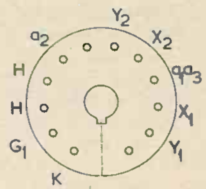
The VCR139A

The VCR139A has base connections as in Fig. 2. However, the author has little other information on this tube as he has had no practical experience with it.

General Points

As a very general guide to the characteristics of the tubes mentioned here, those of the G.E.C. tube type E4205/B/7 may be taken, though the base connections are *not* the same. All the ex-Government c.r.t's the author has seen have a 4V 1A heater.

The author has encountered two faults with these tubes, one of which nearly caused him to scrap one. The first fault is very common and obvious, and is easily remedied. This is that the cement joining the Bakelite base to the glass neck of the tube breaks away. However, when sticking the base back, great care should be taken not to twist the base in relation to the neck of the tube, or either the wires inside the base may short-circuit or the vacuum seal may be damaged. It is possible to check whether or not the wires have been twisted on the B12D based tubes, as will now be explained



Base=B12B
VCR 139A

The second fault may readily cause a perfectly good c.r.t. to be thrown out. The symptom is that one of the tube connections suddenly goes open-circuit or intermittent. If this happens on a B12D based tube, the two countersunk screws on the base should be carefully removed, whereupon the flat part of the base will fall out. It may then be found that the connection which has gone open-circuit has corroded through at the point where it is soldered to the base contact. If this has happened the wire may be soldered back, using a heat sink to prevent the glass seal cracking. When doing this, one should be very careful not to touch the long piece of glass tubing which provides the c.r.t. seal. If this is touched with a hot iron or tapped with the heat sink it may cause the tube to implode.

By removing the base plate one may also check, when gluing back a loose base, that the wires are not twisted together.

The writer hopes that this article may be of some use to readers who would like to use these tubes, and he would advise constructors not to buy other tubes unless they are sure they can obtain information on their base connections and characteristics.

TAILOR-MADE TAGBOARDS

By A. Kinloch

You can make tagboards to any dimensions with this novel cost-saving scheme

TAGBOARDS CAN BE BOUGHT FROM MOST RADIO components suppliers but, when several are required, it is more economical to make them oneself. This can be done very easily with the aid of an eyelet plier (with 300 eyelets) obtainable from Woolworth's stores. The eyelets are intended for fitting to flexible materials, but they can be used for eyeletting rigid sheets if the following instructions are followed.

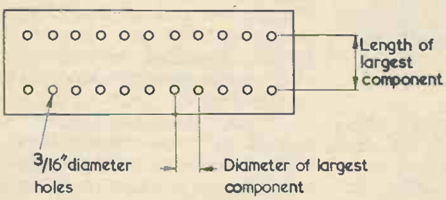


Fig. 1. Drilling the tagboard

1. Obtain a strip of Formica or Paxolin about 2in wide and as long as is necessary. Its thickness should be $\frac{1}{16}$in maximum. Formica offcuts, obtained from a do-it-yourself shop, may be cheaper[1] than Paxolin, and they have the advantage of being suitable for marking with a pencil if one of the lighter colours is used.

2. As shown in Fig. 1, drill two rows of holes with a $\frac{3}{16}$in drill, the rows being spaced from each other by the length of the largest component to be mounted on the tagboard, and the distance between the holes in each row being equal to the diameter of the largest component. Make sure the holes are clean.

3. Obtain a gold-coloured eyelet.[2] These are easily tinned, without preparation, if resin cored solder is used.

4. Insert plunger of pliers through hole. If Formica is used, insert plunger through from plain side.

5. Place eyelet, broad flange up, on plunger. Push it down into hole in board. Keep plunger and eyelet aligned with hole. (See Fig. 2.)

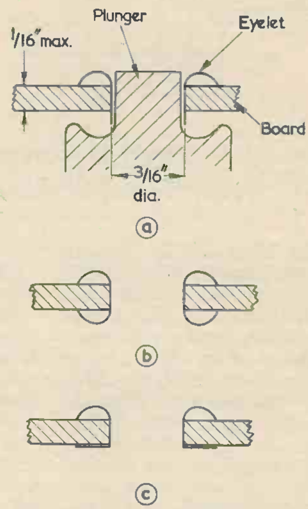


Fig. 2 (a). Inserting the eyelet and pliers

(b). The eyelet after setting

(c). The eyelet after final tightening

6. Close pliers firmly to set eyelet. Though the eyelet is more rigid than the cloth or other materials for which it is intended, Formica and Paxolin are, in their turn, much more rigid than the eyelet. Greater care must be taken when making tagboards than when eyeletting soft materials.

Fig. 3. Soldering a component lead-out to the tightened eyelet

7. After all eyelets have been set with pliers, reverse the board and tap the expanded part of each eyelet with a hammer to tighten it.

[1] A strip measuring 2ft by 2in cost the author 6d.

[2] Any colour, if it is imparted by a *metallic* coating, will be suitable

IN YOUR WORKSHOP

This month Smithy the Serviceman, aided as always by his able assistant, Dick, completes his discussion on the subject of aligning home-built receivers without a signal generator

IT IS AN UNDENIABLE FACT THAT the sturdy foundation and impermeable fabric of the great institutions which make up our British heritage stem from the unshakable traditions built up over the years by disciplined, dedicated and self-effacing men, whose only guiding star is their unselfish devotion to duty. Thus it was in the Workshop, and at no time was tradition more evident than on Friday evenings when Smithy the Serviceman undertook the principal rôle in the ceremony of Handing Over the Staff Pay-Packet.

It was on these occasions, when the last voltage reading had been taken for the day, when the soldering irons had finally cooled down, and the eldritch 400 c/s wail of the signal generators had died away, that Smithy would walk slowly to his desk, extract the small buff packet, and hand it with due solemnity to his waiting assistant. On the particular day on which our episode opens this familiar rite had proceeded in its habitual manner and it concluded, as always, in an outraged reaction from the recipient of the pay-packet.

The Toiler

"Cor," said Dick with complete disgust as he opened the packet. "Cor stone the perishing crows."

The Serviceman sighed.

"I have never yet", he pronounced desolately, "given you a pay-packet for which you have evinced even the slightest particle of gratitude."

"I should think not, indeed," snorted Dick, holding the slip from the packet up in front of the Serviceman. "Just look what they've done to me!"

Smithy peered wearily at the piece of paper.

"It looks all right to me," he announced after a moment.

"All right?" queried Dick in a tone of utter disbelief. "What about all this tax, then?"

Smithy looked once more at the figures on the slip of paper.

"It's exactly the same", he said aggrievedly, "as you pay each week."

"Huh," snorted Dick. "That's the sort of answer us workers always get. We toil all week for our miserable crust, and what happens?"

"I don't know," said Smithy. "What *does* happen?"

"It gets taken from us," replied Dick indignantly, "leaving us a paltry pittance with which to keep up our failing strength and support our ailing family."

Smithy inspected Dick's healthy and well-nourished frame.

"You seem to be doing pretty well on *your* paltry pittance," he remarked. "And, in any case, you haven't *got* an ailing family to support."

"I'm not likely to have, either," said Dick darkly, "after I've paid tax on the measly dole which comes to me each Friday."

Smithy gave up the unequal struggle, and turned to his bench to tidy up his tools and equipment for the night. In the meantime Dick carefully counted the not inconsiderable quantity of notes contained in his packet and carefully stowed them away in his wallet. Suddenly, a thought struck him and his face brightened.

"By the way, Smithy," he called out cheerily. "There's another outstanding matter between us."

Smithy banged the pliers he was holding down on his bench.

"And what's that?" he asked sarcastically. "Have you received ten bob too much?"

"Now, don't be like that," replied Dick. "I'm talking about a further gen session you promised me recently. We were going to finish off our natter about lining up home-built superhets without a signal generator."

Smithy's expression cleared a little.

"Well", he remarked, "I must admit I'd welcome any subject other than lolly at the moment. We've got a quarter of an hour to spare before we pack in for the night, so we might as well devote it to superhet alignment as to anything else. How far had we got?"

Dick, his complaints about the meagreness of his wage already forgotten, settled himself comfortably on his stool and concentrated for a moment.

"If you remember," he said, "we started off with the problems besetting the home-constructor who knocks up a medium and long wave superhet and who doesn't then have a signal generator to line it up with. We carried on to a typical medium wave valve superhet, and to the important point that the oscillator tuned circuit is the one which 'tunes in' the required signal. Adjusting the oscillator trimmer or padding capacitor gives an effect equivalent to adjusting the tuning knob on the front of the set."

"Ah yes," said Smithy. "I remember now. After that, we went on to the instance where you have a variable padding capacitor in series with an air cored oscillator coil. Assuming that the i.f. stages are already lined up, the process of alignment then consists of adjusting the oscillator trimmer at the high frequency end of the band so as to 'tune in' a signal whose frequency corresponds to tuning dial calibration, and of adjusting the aerial trimmer so that this signal comes in at maximum strength. After which, the tuning capacitor is turned to the low frequency end of the band and the oscillator padding capacitor adjusted to 'tune in' a second signal whose frequency also corresponds to dial calibration. If this procedure is repeated again and providing the aerial tuned winding has the correct inductance, the whole range can then be considered as being lined up."

"You next", chimed in Dick, "changed from an air cored oscillator coil to an iron dust cored type, replacing the variable padding capacitor with a fixed capacitor having a value appropriate to the range. Whereupon the procedure was the same as before, except that you padded by adjusting the iron dust core of the oscillator coil at the low frequency end of the range instead of the variable padding capacitor."

"That's right," confirmed Smithy. "Incidentally, an iron dust cored oscillator coil and air cored aerial coil is the sort of combination you'll find in such things as medium and long wave receivers with open frame aerials. The inductance of the aerial tuned winding in such receivers is fixed and cannot be altered."

Adjustable Aerial Inductance

Smithy drew a notebook towards him and beckoned his assistant over.

"We'll now," he announced, sketching out a circuit in the notebook, "carry on to fresh ground. Let's take a look at the case where the aerial tuned winding also has adjustable inductance. This will occur if the coil is fitted with an adjustable iron dust core. (Fig. 1.)

"In this instance the alignment procedure is much the same as before, but we have the considerable advantage of having another variable in the circuit. As occurred in the previous case, we start off by setting the two-gang tuning capacitor to the high frequency end of the band with its moving vanes some 10 to 20 degrees short of being fully disengaged. We inject a signal into the aerial circuit whose frequency corresponds to dial calibration, and we 'tune in' this signal with the oscillator trimmer. Next, we bring it up to maximum strength with the aerial trimmer. We then go down to the low frequency end of the band, with the ganged capacitor vanes fully enmeshed except for some 10 to 20 degrees, and inject a new signal which once more corresponds to dial calibration. We 'tune in' this new signal with the oscillator dust core. Finally—and now we come to the new bit—we bring this signal up to maximum strength by adjusting the aerial coil iron dust core."

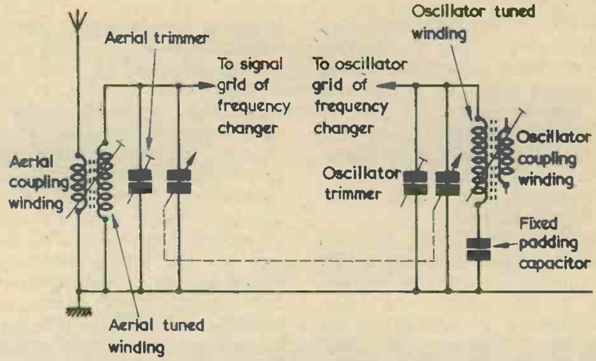


Fig. 1. The tuned circuits in the frequency changer stage of a medium wave valve receiver when both aerial and oscillator coils have adjustable iron dust cores. The two variable capacitors comprise a two-gang component. A.G.C. components are omitted for simplicity

"I'm with it," said Dick. "This adjustment is the same as the padding adjustment to the oscillator tuned circuit. You align the aerial tuned circuit by varying the trimming capacitance at the high frequency end of the band, and by varying the coil inductance at the low frequency end. Just like you do with the oscillator tuned circuit!"

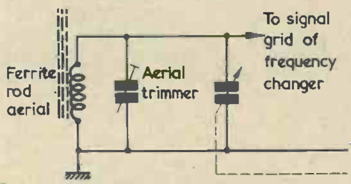


Fig. 2. If a ferrite rod aerial is employed instead of the iron dust cored aerial coil of Fig. 1, an adjustment of aerial tuned circuit inductance is still possible

"That's the idea," said Smithy. "And the great advantage which results is that you now *know* that the aerial tuned circuit is resonant at correct frequency at the low frequency end of the band, because you've adjusted the aerial tuned inductance to make it so. With the circuits I showed you during our last session you had to keep your fingers crossed that the coil manufacturer had put the right inductance into the coil. If he hadn't, you had to bodge things around in the manner I described at that time."

"The variable aerial inductance is a big improvement," commented Dick. "It makes everything very much easier, doesn't it?"

"It does indeed," replied Smithy. "You'll get the same effect with a ferrite rod aerial as well, of course. (Fig. 2.) If a ferrite rod aerial is used, you adjust the aerial trimmer at the high frequency end of the range exactly as before. You then go down to the low frequency end and 'tune in' your signal with the oscillator iron dust core, after which you bring the signal up to maximum strength by sliding the aerial coil along the ferrite rod. (Fig. 3.) If you slide it towards the centre of the rod you increase its inductance. If you slide it towards the end of the rod you reduce its inductance."

"That's simple enough," commented Dick. "How do you inject the signal into the ferrite rod?".

"If you *have* got a signal generator," replied Smithy, "you couple its output to a coil having about half a dozen or so turns and a diameter of three to six inches. This coil is mounted a short distance away from the end of the ferrite rod so as to give an inductive coupling to it. The dimensions and turns of

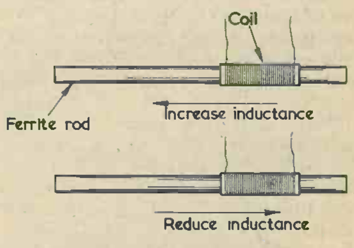


Fig. 3. It is conventional practice to wind a ferrite rod aerial coil on a former which is a sliding fit on the rod. Inductance increases as the coil is moved towards the centre of the rod, and reduces as it is moved towards the end

the coil aren't terribly important provided it gives you the desired inductive coupling. If you don't have a signal genny you just work with received signals. And we are, of course, mainly interested at the moment in the case where no signal generator is available."

"Of course we are," said Dick. "I keep forgetting that!"

"There are", continued Smithy, "a few more points I would now like to clear up before proceeding further. The first is that, with some commercial receivers or sets made up from kits, the service manual or the kit instructions will tell you the points on the tuning dial at which you should trim and pad. If they don't, then it's safe on medium waves to trim with the tuning capacitor vanes 10 to 20 degrees short of being fully disengaged, and to pad with the tuning capacitor vanes 10 to 20 degrees short of being fully enmeshed. Also, since the trimming adjustments will slightly affect the padding adjustments, and vice versa, you have to go through the whole trimming and padding routine at least twice to get everything spot-on. If the alignment is badly out when you commence, it would be worth repeating the whole operation a third time or, even, a fourth time."

Tuning Scales

"There's something," remarked Dick, "that I've just thought of."

"What's that?"

"We've assumed up to now," said Dick, "that the receiver has got a tuning scale. However, many home-constructor sets just don't have tuning scales. Indeed, the sets are built first and the tuning scales appear afterwards!"

"That's true enough," chuckled Smithy. "This represents the case where the home-constructor buys a set of coils and couples them up to a two-gang tuning capacitor in the usual manner, after which he has to start alignment completely from scratch. Things are still not too difficult, however, because the coil manufacturer will state the range of his coils when they are used with a particular value of tuning capacitor, and this gives you all the clues you want. One way of starting alignment then consists, after the i.f. stages have been lined up, of setting the tuning capacitor to minimum capacitance with its vanes *completely* disengaged. You then adjust the oscillator trimmer to 'tune in' a signal whose frequency corresponds to the high frequency limit of the band as quoted by the coil manufacturer. If you like, you can roughly align the aerial trimmer at the same time, bringing the incoming signal up to maximum strength. You next set the tuning capacitor to maximum capacitance with the vanes *completely* enmeshed. With the oscillator iron dust core you then 'tune in' a signal whose frequency corresponds to the low frequency limit of the band, as quoted by the coil maker. Again, you can roughly align the aerial core or adjust the position of the aerial coil on the ferrite rod, until this signal is also at maximum strength. You next repeat the oscillator trimmer adjustment with the tuning capacitor vanes fully disengaged, and the iron dust core adjustment with the tuning capacitor vanes fully enmeshed, and the two ends of the range should then finally agree with the figures quoted by the coil manufacturer. The result of all this is that your oscillator circuit now covers the specified range for the coil. It shouldn't be adjusted any more, and you then turn your attention to the aerial tuned circuit. Set the tuning capacitor vanes so that they are disengaged by about 10 to 20 degrees and, if you have a signal generator, inject a signal whose frequency is accepted by the receiver. Remember that in this case, so far as the choice of signal frequency is concerned it is the oscillator circuit which is now in command and not the tuning scale or the signal generator. In practice, the signal frequency provided by the signal generator will, of course, be just a little lower than that at the high frequency end of the range. If you haven't got a signal generator, tune in a signal which falls into the 10 to 20 degree region. You then trim the aerial circuit for maximum signal strength. You next go to the low frequency end with the tuning capacitor vanes 10 to 20 degrees short of being fully enmeshed and repeat the operation by adjusting the inductance of the aerial tuned coil. As I just said, the thing to remember is that the oscillator circuit is now in command all the time so far as signal frequency selection is concerned, because you have set it up to agree with the coil maker's range figures. All you are finally doing is to bring the aerial tuned circuit up to scratch at the usual trimming and padding points."

"This sounds a bit too good to be true," commented Dick. "Are you sure that you'll always be able to align the oscillator circuit to the top and bottom frequencies as easily as that?"

"I wouldn't be too dogmatic about it," admitted Smithy. "You might, for instance, have a tuning capacitor with a bit more or a bit less capacitance than it's supposed to have. And there may be other factors which qualify operation. But there's no need to worry about this, and all you'll find as a result is that the desired top frequency is not quite within oscillator trimmer range or that the desired bottom frequency is not quite within oscillator iron dust core range. Unless there is a fault somewhere the top and bottom frequencies should, however, be only a wee bit out, whereupon you can accept the situation. In this instance you work to a top frequency which is near to the required one whilst still giving you a bit of oscillator trimmer adjustment in hand. Similarly, you work to a bottom frequency which is near to the required one but which still gives you a bit of oscillator iron dust core adjustment in hand."

"That seems", commented Dick, "to be a commonsense approach."

"It is," replied Smithy. "Although it *can* be a bit confusing to the newcomer. The main thing to do is to always bear in mind the principles involved, remembering that it is the *oscillator* tuned circuit which selects the signal to be received."

"What happens," asked Dick, "if you just go out and buy a set of coils from one maker, a tuning capacitor from another maker and a tuning dial from a third maker?"

"If you're lucky," replied Smithy, "they should all go together quite nicely. Unless the tuning capacitor is badly out so far as its maximum capacitance is concerned, you should be able to get the oscillator tuned circuit to agree with the medium wave scale at the high frequency end when the tuning capacitor vanes are disengaged by about 10 to 20 degrees, and at the low frequency end when the vanes are fully enmeshed except for 10 to 20 degrees. If the tuning capacitor has a different law than that for which the tuning dial was designed you'll get some small discrepancies in calibration between the high and low frequency ends but, in the circumstances, you'll just have to put up with these."

"What do you mean," asked Dick, "by different law?"

"The law of a tuning capacitor," explained Smithy, "is the relationship between vane rotation and capacitance. It depends upon the shape of the vanes. But there's no need to let it worry us here because there shouldn't be a very great difference between the different laws so far as tuning capacitors sold on the home-constructor market are concerned."

Tracking

"There's another point," remarked

Dick, "which I've just remembered."

"Oh yes," replied Smithy, "and what's that?"

"The purpose of the trimming and padding operations," said Dick, "is to ensure that the aerial tuned circuit always resonates at a frequency which is equal to oscillator frequency minus the intermediate frequency. We know that this is true at the trimming and padding points, because we set up the trimmers and dust cores accordingly. But what happens in between?"

Smithy chuckled.

"I was wondering," he grinned, "how long it would take you to get round to that! What you've introduced here is the important question of tracking. With the superhet, the term 'tracking' defines the ability of the signal and oscillator tuned circuits to maintain a fixed frequency difference when they are adjusted by a common control. If, at all positions of the ganged tuning capacitor, the resonant frequency of the signal tuned circuit is always lower than that of the oscillator tuned circuit by the intermediate frequency, you have perfect tracking."

"Blimey," said Dick. "From the way you put it, it sounds as though perfect tracking is something that's difficult to achieve."

"It isn't only difficult," replied Smithy, "it's well-nigh impossible! Or, at least, it's well-nigh impossible in theory. If you have a well-designed frequency changer circuit you'll get a tracking curve which is only correct at three points (Fig. 4). Tracking is correct at the trimming and padding points and at a frequency which is about halfway between. At all other points there is an error either in one direction or in the other."

"Dash it all," exploded Dick, "that's a lot of help, I must say! What's the use of going through all this rigmarole of trimming and padding if the circuits are going to be out of bonk over nearly all the rest of the scale?"

"Hold your horses," soothed Smithy, "things are by no means as bad as all that! The curve I've sketched out looks pretty awful, I'll admit, but that's only because I've rather exaggerated the errors. If, with a good quality set of medium wave coils, you get three-point tracking as in the curve you'll find that the error at all other points is almost negligible. The way to test this statement out is to get a good medium wave receiver, trim and pad it up carefully, then check at various points over the range to see how much adjustment the aerial trimmer needs to bring the aerial tuned circuit spot-on to its correct frequency. You'll find, in practice, that the adjustment you need, at even the worst places, is very small indeed."

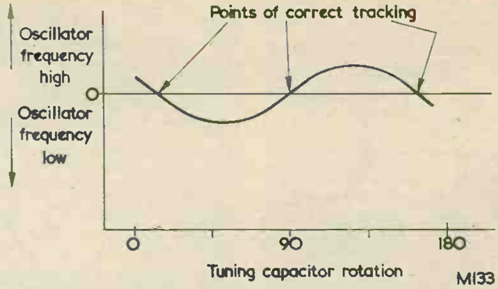


Fig. 4. A tracking error curve representative of what may be provided by practical two-gang superhet tuning circuits. The oscillator and signal frequencies have the correct frequency difference relationship only when the curve is on the zero line

"Perhaps so," conceded Dick, "but you're talking about a commercially-made receiver or a set of that order. What *I'm* talking about are home-made sets where you've just bought the odd pair of coils on spec."

"There's no reason," replied Smithy, "why the same, or very nearly the same, degree of tracking accuracy shouldn't be obtained. The essential point here is to ensure that the fixed padding capacitor used with the oscillator coil is *exactly* the value specified by the coil manufacturers. A silvered mica capacitor should be employed here and I, personally, wouldn't dream of using a component whose tolerance was greater than $\pm 5\%$. Many set manufacturers employ $\pm 2\%$ components in the medium wave padding capacitor position, so that will give you an idea how critical this component is."

"I see," said Dick. "I must remember that point in future. There's another thing I'm not too certain about, and that concerns the tuning capacitor. Some two-gang tuning capacitors don't have the same capacitance in each section."

"That's right," confirmed Smithy. "One of the sections has smaller vanes and is intended to be employed in the oscillator circuit. Since it offers a lower capacitance you can connect it directly across the oscillator tuned winding, and you don't need the fixed padding capacitor."

"That's just the job, then," commented Dick. "All problems of tracking and padding are solved in one step!"

"I'm sorry," replied Smithy, "but I'm afraid they're not. The reason is that two-gang capacitors of this nature are carefully designed to operate with a particular intermediate frequency in the 450 to 480 kc/s range, and over a particular range of frequencies in the medium wave band only. You still need a fixed padder if you're going to receive long waves. Also, you still have to adjust the oscillator iron dust core. If a two-gang capacitor of this nature is part of a receiver kit then I will agree that it is a very useful component. But it could give you quite a lot of trouble if you tried to use it with just any odd set of coils, because it may not offer the effective padding capacitance such coils require. It would be safer to employ an ordinary ganged capacitor and the fixed padding capacitance specified by the coil maker."

Aligning the Receiver

"That seems fair enough," conceded Dick. "Now, how about the actual alignment of a home-built receiver without a signal genny?"

"Right you are," said Smithy, equably. "We'll start off with the medium wave valve receiver we've used as an example all along. Let's assume that you've bought yourself a medium wave aerial coil or a medium wave ferrite rod aerial, a medium wave oscillator coil, and a pair of i.f. transformers whose nominal frequency is in the range of 450 to 480 kc/s. You have carefully assembled these together on a chassis using a good and reliable circuit, you have checked all connections and wiring, and you now want to switch on and tune in Radio Luxembourg. Also, of course, you haven't got a signal generator.

"You begin," continued Smithy, "by the simple process of switching on the receiver, turning the volume up to full and giving it a minute or so to warm up. If you're not using a ferrite frame you couple a reasonable wire aerial to the aerial coupling coil. After which you carefully adjust the tuning capacitor until you pick up a signal."

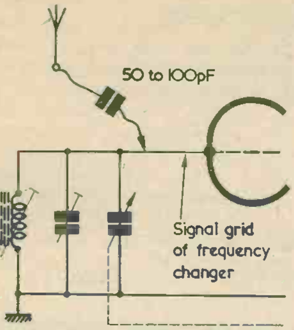


Fig. 5. During initial alignment, it may prove helpful to temporarily connect an aerial to the signal grid of the frequency changer, as shown here

"Just like that?"

"Just," confirmed Smithy, "like that! If you can't hear anything at all, temporarily connect a wire aerial to the signal grid of the frequency changer via a 50 to 100pF fixed capacitor (Fig. 5). This will bypass the aerial tuned circuit and allow at least the local station to beat with the oscillator frequency."

"But how does the signal get through the i.f. amplifier?" asked Dick. "When you're starting off raw like this, your i.f. transformers will be miles out of alignment."

"No they won't," said Smithy. "What you forget is that the last check the manufacturer does at the i.f. transformer factory is to pop each transformer into a test jig which presents more or less the same circuit conditions which you have in your receiver. The transformer is then aligned to the nominal i.f., and its performance checked on a 'scope or a meter. The result is that, when you buy it, it's already aligned for you! If you connect it into your receiver with reasonably short leads and with the tag connections specified by the maker, then it will be very nearly spot-on. In consequence, you should be able to get at least a weak signal through the i.f. amplifier of your receiver immediately after switching on."

"I'm beginning to see what you mean at our last session," said Dick, "when you talked about not messing about with the cores of i.f. transformers and coils before using them."

"Good," commented Smithy, briskly. "The important thing is *never* alter the core positions in any home-constructor coil or i.f. transformer until you've got it wired up into the set. This is because the cores, and especially those of the i.f. transformers, should have been placed very near to their final position as a result of factory tests. Anyway, let's return to our receiver. Unless something is wrong you should, after switching on, almost certainly be able to pick up a signal in the manner I've just described. The next thing to do is to tune in that signal to maximum strength by means of the tuning capacitor, paying no attention whatsoever to dial calibration or anything like that. Next, leave the tuning capacitor severely alone and align the i.f. cores for maximum signal. If, at the end of this operation, signal strength is very high, reduce it by reducing aerial length or by orienting the ferrite rod. You may even have to tune in a weaker station if the existing station is now too strong. One of the secrets of successful alignment is to finish off with a signal which is just audible above background noise. Such a signal isn't masked by a.g.c. action and it makes alignment peaks much more obvious. You'll be quite unlucky if, at the end of this procedure, your i.f. amplifier isn't aligned at, or close to, the desired frequency."

Smithy pasued for a moment to collect his thoughts.

"The next job," he said, "consists of trimming and padding the aerial and oscillator coils, and we've already gone into that. In this instance you *might* find that you have to alter core positions quite a lot more than was necessary with the i.f. transformers, but don't lose too much sleep over it. Ferrite rod aerial coils may, in particular, be quite a long way from their final positions on the rod but this can be due to a lot of factors. If they were set up at the factory, they may, for instance, have shifted whilst being despatched."

"How do you get your trimming and padding frequencies?" asked Dick.

"From stations which are on the air," replied Smithy. "If possible, it's a good plan to have another receiver available. It's difficult to identify individual stations in the B.B.C. Home network because these usually all transmit the same programme at the same time. So you will probably find it easier to work with Continental stations, whereupon your second receiver will enable you to identify these and the points on the dial at which they should appear. There are stacks of powerful Continental stations which you can receive in the evening and at night time, and you select those whose frequencies are closest to the required ones needed for trimming and padding. Signal strength is unimportant so far as oscillator tuned circuit adjustments are concerned, but you always want to try and make your final aerial tuned circuit adjustments with as weak a signal as possible."

"What about a medium wave receiver using transistors?"

"You follow exactly the same routine as with the valve receiver. The i.f. transformer cores should be very near their final positions and so, once more, you first of all try to get a signal through the i.f. amplifier. It may help here to temporarily apply a wire aerial to the base of the mixer-oscillator via a 1,000pF capacitor during initial alignment (Fig. 6). You *must* get the i.f. amplifier lined up first before you touch anything else. You then trim and pad as for the valve set."

Long Waves

"What," asked Dick, "about long waves?"

"The long wave band," said Smithy, "is trimmed and padded in much the same way as the medium wave band. It will have its own fixed padding capacitor, this having a lower value than that needed for medium waves, and a typical value here would be of the order of 150pF. You will probably find that tracking on long waves is not as good as on medium waves, particularly near the ends of the tuning range. In consequence, and unless otherwise detailed in the instructions for the receiver, it's usually preferable to trim with the vanes engaged by, say, 20 to 30 degrees and to pad with the vanes fully enmeshed except for 20 to 30 degrees. This procedure should result in the B.B.C. long wave Light Programme transmitter coming in at about its correct position on the dial with the aerial trimmer at or very near its correct point. If the receiver is a valve set using iron dust core aerial coils instead of a ferrite rod aerial, you may well have a circuit in which the medium wave coils are

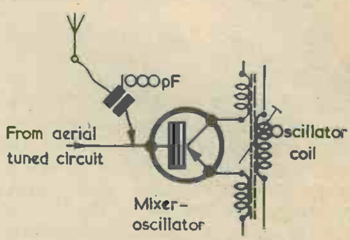


Fig. 6. With transistor receivers, a temporary aerial connection can be made to the base of the mixer-oscillator via a 1,000pF capacitor

completely switched out on long waves, and vice versa. Alignment is then a piece of cake because adjustments on the long wave band do not affect medium wave band alignment, nor do medium wave adjustments upset the long wave band alignment. If the circuit uses a ferrite frame, you may find that the long and medium wave coils are in series, the long wave coil being shorted out on medium waves. In this instance the settings of the medium and long wave windings on the ferrite rod tend to affect each other a little. The thing to do here is to carry out the medium wave alignment first and then the long wave alignment. You next go back to medium waves and finally adjust the medium wave ferrite rod coil for best position at the medium wave padding frequency, then return to long waves and adjust the long wave ferrite rod coil for best position at the long wave padding frequency. If the long wave coil needs more than a small amount of adjustment, it would be advisable to finally repeat the medium wave adjustment once more."

"This all seems clear enough," commented Dick. "However, some sets don't have coil switching which isolates the two bands so completely as the type you've just referred to."

"True enough," agreed Smithy. "You'll find that many commercially made valve receivers employ circuits in which the various adjustments have to be made in a particular order because of common trimmers, or things of that order. The same applies to the majority of transistor superhets on the home-constructor market at the time being. These usually employ a single oscillator coil both for medium and long waves and, here again, the aerial and oscillator trimmers and dust cores have to be aligned in a certain order for correct results. It's impossible to particularise here, because there are so many different versions. There's no real problem though, because alignment then proceeds as described in the instructions for the kit, or in the magazine article in which the circuit appears."

Packing Up

"Summing up," said Dick thoughtfully, "it would seem that the first secret of lining up a medium and long wave superhet without a signal genny consists of getting the i.f. amplifier correctly aligned before you tackle anything else."

"That's right," said Smithy. "And don't forget you've got to line up the i.f. amplifier first even when you use a signal generator."

"As you say," agreed Dick. "Whereupon, so far as the home-constructor is concerned, the most important thing is to avoid the temptation to fiddle about with the i.f. transformer cores until he actually comes to adjust them."

"That's correct," confirmed Smithy. "Unless you're very unlucky, you should be able to rely on the pre-alignment resulting from the factory test to enable you to get a signal through the i.f. amplifier first go."

"What happens if you're unlucky?"

"If you're unlucky," said Smithy, "then you have to accept the inevitable and bring a signal generator into use to get the i.f. amplifier on to correct frequency. But my own experience tells me that, in the vast majority of cases, and provided a little common sense is employed, it's quite possible to get a home-constructor medium and long wave superhet reliably lined up without using a signal generator at all."

Smithy glanced at the Workshop clock and gave a start.

"Do you know," he snorted, "I've been nattering here for a good half-hour after packing-up time? Now that you're flush, how about standing me a cup of char and a wad down at Joe's Caff?"

"Me stand you?" queried Dick indignantly. "Blimey, just how tight can you get? Weren't *you* paid today?"

"Of course not," replied Smithy, affronted. "A man of my standing and responsibility has his salary paid into his bank account once a month."

"It's the end of the month now!"

"Ah yes," said Smithy, relentlessly steering his reluctant assistant through the door. "But the bank isn't open now. Whereas Joe's Caff is!"

book reviews . . .

LOUDSPEAKERS. By E. J. Jordan. 227 pages, 5½ x 8½in. Published by Focal Press. Price 42s.

This book, which appears in the Focal Press "Technique of Sound Reproduction" series of titles, deals with both the theoretical and practical aspects of loudspeaker design and performance. Where mathematics are required to put over particular points, mathematics are used; but this need not deter the reader who seeks information of a less precise character, as he is also catered for. The book covers, in detail, a wide range of subjects in the reproducer field, these including sound radiation, loudspeaker drive systems, cones and suspensions, dividing networks, enclosures, electrostatic loudspeakers and stereo reproduction.

STEREO FOR BEGINNERS. By B. J. Webb. 118 pages, 5½ x 8½in. Published by Miles Henslow Publications Ltd. Price 7s. 6d.

It is a pleasure to review a book that sets out, with complete competence, to do exactly what its title indicates. *Stereo For Beginners* gives advice which is aimed at exactly the right level, and it is always leavened with a commendable admixture of common-sense. Thus, in the chapter "Converting To Stereo" we find: "The conversion of a record player or ordinary one-piece radiogram to stereo is just not worth while. If you have an instrument of this kind in good condition, and you wish to go over to stereo, by far the best thing you can do is to sell it, give it to someone for a wedding present or, if it is quite modern and has been well kept externally as well as being electrically sound, trade it in when getting new equipment." Good sensible advice such as this is met throughout.

Stereo For Beginners is intended for the high fidelity enthusiast who purchases his equipment ready-made from the various manufacturers in this field. It is not a "constructional" book in so far as the reader is not expected to build, say, his own amplifier. Indeed, a high level of technical knowledge is not required of the reader at all, apart from an ability to understand the simple basics of tape and disc recording. The book covers the history of stereo; stereo recording; stereo from discs, tape and radio; the purchase, installation and maintenance of stereo equipment; and room acoustics and phasing. There is an excellent chapter devoted to typical questions and answers, this dealing, amongst other things, with the problems of matching together different items of equipment which so beset the newcomer to high fidelity reproduction.

At its low price of 7s. 6d., *Stereo For Beginners* represents excellent value, and can be confidently recommended to those readers who wish to embark on stereophonic reproduction in the home.

Basic Superhet for Beginners

by James S. Kent **Part 1**

In this two-part series, the author commences by describing a basic receiver design suitable for construction by beginners and continues in Part 2, to be published next month, with various additions and modifications which may be carried out to the basic design

IT IS THE GENERAL EXPERIENCE OF MOST RADIO hobbyists that there eventually occurs the phase when, having constructed and operated several "straight" or t.r.f. receivers, the urge to build a superhet gradually becomes the dominant factor with reference to future plans. It is at this particular point that most enthusiasts pause, somewhat dismayed and uncertain—or even puzzled, at the perils and much overrated difficulties of launching upon such a venture.

Such a hobbyist, wishing to construct a superhet, soon finds that the first hurdle to clear is the obtaining of a sound and proven design which is adequately suited to his needs. Comparatively new to the technique and without an extensive radio library to consult, he must perforce await publication in the current radio press for a suitable design to appear—whereupon the chances are that it may either be beyond his capacity in both complexity and cost or unsuitable for other reasons. The real need, of course, is for a receiver which can be constructed firstly in basic form, and later expanded stage by stage into a communication type equipment. With such a design he is able, having built the basic circuit satisfactorily, to add the various additional stages as time and available cash permit. Alternatively, he is able to discontinue constructing additions, leaving the receiver completed at any particular stage of advancement as and when he wishes. Again, the beginner is able, by the means presented here, to build the design in easy stages —a great advantage from many points of view.

In this article the beginner will find that all these considerations have been borne in mind, the only assumption being that, having previously constructed several t.r.f. designs, the reader is perfectly capable of following a circuit diagram. With the receiver featured here, all the components are currently available on the market and miniature valves are employed.

Prior to commencing construction, the reader may well be advised to study this two-part article in its entirety and, having done so, to arrive at a decision as to which form the completed receiver will take. For example, if it is decided to add an extra i.f. stage after the basic circuit is completed, sufficient chassis space must be allowed at the outset for such an addition. Alternatively, the valve holder and i.f. transformer could be mounted in position at the time of initial construction—the wiring up of this stage then taking place at a later date. Such forethought also applies to all the additions appearing in Part II of this series, and a careful appraisal of these will repay the intending constructor during the later stages, and indeed in the final outcome, of the completed receiver.

Basic Receiver

A careful study of Fig. 1 will show that the receiver conforms to sound standard practice, comprising a frequency changer (ECH42), an i.f. stage (EF41), detector, audio and a.g.c. stage (EBC41), and an output stage (EL41). This is the basic design around which the home constructor can incorporate the refinements to be described later, and which can also be very easily converted into a communications type receiver if this is so desired. Alternatively, with the addition of the power supply (see Fig. 3) this design will prove to be excellent as an ordinary long, medium and short wave receiver for domestic use.

Coils and Coilpacks

The coilpack is of great importance by virtue of the fact that it comprises the heart of the receiver and also, in conjunction with the variable capacitors (C_2, $_3$, $_7$ and $_8$), determines the frequency coverage of the set.

In the design featured, it is assumed that the reader intends to construct the receiver in order to later convert this into a communications set. This being so, the coilpack specified in the Components List is one which covers medium wave, long wave, and two short wave ranges. However, the type specified need not necessarily be incorporated, as there are others with various frequency coverages which are also available. With these units, the maker includes full connection details together with

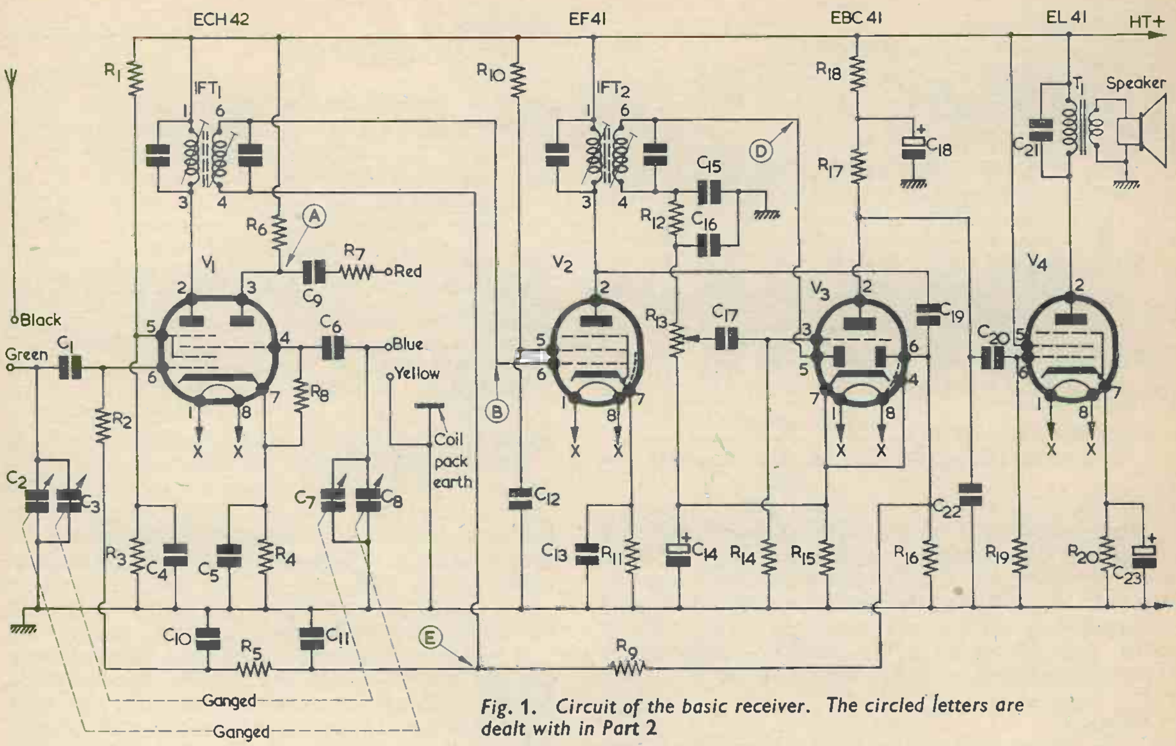


Fig. 1. Circuit of the basic receiver. The circled letters are dealt with in Part 2

Components List
(Figs. 1 and 3)

Resistors
(All fixed resistors ½ watt 10% unless otherwise specified)

R_1	27kΩ 1 watt
R_2	1MΩ
R_3	27kΩ 1 watt
R_4	180Ω
R_5	220kΩ
R_6	33kΩ
R_7	150Ω
R_8	47kΩ
R_9	1MΩ
R_{10}	100kΩ
R_{11}	270Ω
R_{12}	22kΩ
R_{13}	250kΩ pot log track, with d.p.s.t. switch
R_{14}	1MΩ
R_{15}	3.3kΩ
R_{16}	1MΩ
R_{17}	150kΩ
R_{18}	25kΩ
R_{19}	470kΩ
R_{20}	200Ω

Valves

V_1	ECH42 Mullard
V_2	EF41 Mullard
V_3	EBC41 Mullard
V_4	EL41 Mullard
V_5	EZ40 Mullard

Capacitors

C_1	100pF silver mica
C_2	500pF variable (ganged with C_8)
C_2	25pF variable (ganged with C_7)
C_4	0.01μF tubular (Mullard)
C_5	0.01μF tubular (Mullard)
C_6	50pF silver mica
*C_7	25pF variable (Home Radio Ltd., Cat. No. VC69)
C_8	500pF variable (Denco Ltd.)
C_9	200pF silver mica
C_{10}	0.05μF tubular (Mullard)
C_{11}	0.05μF tubular (Mullard)
C_{12}	0.1μF tubular (Mullard)
C_{13}	0.01μF tubular (Mullard)
C_{14}	25μF electrolytic 12V wkg.
C_{15}	200pF silver mica
C_{16}	200pF silver mica
C_{17}	0.01μF tubular (Mullard)
C_{18}	4μF electrolytic 350V wkg.
C_{19}	50pF silver mica
C_{20}	0.01μF tubular (Mullard)
C_{21}	0.002μF paper
C_{22}	100pF silver mica
C_{23}	25μF electrolytic 25V wkg.
†C_{24}	32μF electrolytic 350V wkg.
†C_{25}	16μF electrolytic, 350V wkg.

*See text
†C_{24} and C_{25} are in a single can

Output Transformer

T_1	Type 117E (H. L. Smith & Co. Ltd.)

I.F. Transformers
IFT_1 465 kc/s type IFT11
IFT_2 465 kc/s type IFT11
(Denco Ltd.)

Mains Transformer
Pri: 0–200–220–240V; Secs: 250–0–250V, 120mA; 6.3V (centre-tapped) 4A; 6.3V, 1A. Type 7023 (H. L. Smith & Co. Ltd.)

L.F. Choke
L_1 10H, 120mA, 200Ω, Type M101 (H. L. Smith & Co. Ltd.)

Dials
Panel Signs transfers, Set No. 6

Flexible Coupler (C_3 C_7)
Eddystone (Home Radio Ltd., Cat No. 893)

Valveholders
B8A (5 off) (McMurdo)

Speaker
3Ω impedance

Coilpack
Type CP3F (Denco Ltd.)

Fuse and Holder
Cartridge type with 1A fuse (H. L. Smith & Co. Ltd.)

Chassis and Panel
See text (H. L. Smith & Co. Ltd.)

Metal Stand-off Bracket (C_7)
Home Radio Ltd., Cat No. 708/A

other information on the pack. Usually only five soldered connections are required to wire the pack to the remainder of the circuit. From the foregoing it will be seen that the choice of coilpack largely depends on the reader's intentions with regard to the final outcome of the receiver—domestic or communications.

Valves

The valves employed in the design are taken from the Mullard B8A range. These have a number of advantages, particularly when compared with older valves of the octal type. Their performance in a circuit of this nature is equivalent to that which would be offered by B7G and B9A valves, and they are available in the component market at low cost. The i.f. amplifier and double-diode-triode valves incorporate internal screens, and this feature provides an advantage in that external metal screens for these valves, which are the most susceptible to unwanted external couplings, are not then required.

I.F. Transformers

These components are extremely important in any superhet and those specified are of the modern miniature type having a high "Q". As supplied by the manufacturer, they are complete with full connection details and other data. It is recommended that the types specified are obtained. Connections for these are shown in Fig. 1.

Resistors and Capacitors

For best results there is no doubt that new and branded components are best in the long run and, although some tolerances are admissible in the design, it is far better, and cheaper, to obtain the values specified. The use of surplus components is not advised.

Speaker and Transformer

These are specified in the Components List but it may be that a speaker is already to hand. This being so, there is no reason why it should not be used providing that it will match into the output transformer.

Circuit-Frequency Changer

It will be noted from Fig. 1 that the frequency changer stage is built around the triode-hexode ECH42. This is an excellent valve for use in a receiver designed to work on the short wave ranges. After an initial warming up period, there is little or no frequency drift apparent—a very important point at the comparatively high frequencies encountered on short waves.

The valve base connections are shown as numbers around the circuit representation for the valve. The hexode screen grid is fed from the h.t. positive line via R_1 which, with R_3, forms a potentiometer. The capacitor C_4 is the bypass component. The grid of the hexode (pin 6) is connected to the green tag of the coilpack via C_1 (see Fig. 2 (*a*) and (*b*)), and to the variable capacitors C_2 and C_3. The variable capacitor C_2 is the main tuning component and is one section of the 500pF two-gang capacitor. The small bandspread capacitor C_3 is wired in parallel across C_2. The required trimming capacitors, not shown in Fig. 1, are supplied with the coilpack and are an integral part of this unit as received from the manufacturer or supplier.

The hexode anode is connected to the h.t. positive line via the i.f. transformer primary winding, the secondary winding of which is connected to the following stage, V_2, and the a.g.c. (automatic gain control) line.

The cathode of V_1 (pin 7) is taken to chassis (earth) via the resistor R_4, and is bypassed by C_5. The oscillator triode anode (pin 3) is connected to the red tag of the coilpack via the components C_9 and R_7. The oscillator grid (pin 4) is wired to the coilpack (blue tag) via C_6 and also to the cathode via the resistor R_8. The oscillator grid is tuned by the variable capacitors C_8 (500pF main tuning) and C_7 (bandspread).

A.G.C. is applied to the grid of the hexode (pin 6) from the a.g.c. line via R_2.

Coilpack

The coilpack connections are shown in Figs. 2 (*a*) and (*b*) as well as Fig. 1. The black tag connects to the aerial input and the yellow tag to chassis. Fig. 2 (*a*) is the circuit representation whilst Fig. 2 (*b*) shows the physical layout of the pack and the required connection points, together with the associated trimmer capacitors.

The coilpack specified covers the following ranges when a tuning capacitor with a 500pF "swing" is used (although this coverage is slightly altered with the addition of the bandspread capacitors C_3 and C_7): long wave, 800 to 2,000 metres (375 to 150 kc/s); medium wave, 194 to 550 metres (1,546 to 545 kc/s); short wave 1, 50 to 160 metres (6 to 1.85 Mc/s); and short wave 2, 16 to 50 metres (18.75 to 6 Mc/s).

With such a frequency coverage (16 to 2,000 metres approx.) it will be readily appreciated that, in order to receive signals on wavelengths below 16 metres, it will be necessary to construct a converter for use with the receiver. This in itself is no disadvantage for, in order to adequately cover such higher frequencies efficiently, a converter is really necessary in the writer's opinion.

The specified bandspread capacitors C_3 and C_7 are single gang components which must be ganged together by means of a flexible coupler, the rear capacitor (C_7) being secured to the chassis by means of a metal stand-off mounting.

The switch positions for the various ranges are also shown in Fig. 2 (*b*).

I.F. Stage

The EF41 is a variable mμ pentode which is eminently suitable as an i.f. amplifier in receivers of the type discussed here. It is fitted with an internal screen, and the anode and control grid lead-out wires are screened from each other, with a resulting grid to anode capacitance of less than 0.002pF. This results in the risk of undesirable feedback from anode to grid being reduced to a minimum. The third grid, i.e. that nearest the anode, is internally connected to the cathode and to the valve screen. It should be noted here that valveholder tags corresponding to the apparently blank valve pins (those to which no connections are shown) should *not be used as anchoring points* for other components. This applies also to the EL41 in the V_4 position. These are "internal connections" pins, and are used internally within the valve as supports for other electrodes—hence the basic rigidity of the valves electrode structures as a whole.

Cathode bias is applied to V_2 by way of the components R_{11} and C_{13} whilst h.t. potential is supplied via R_{10} to the screen grid (pin 5), this being bypassed to chassis via C_{12}. The anode is connected to the h.t. positive line via the primary winding of IFT_2.

The i.f. stage is of great importance in this, as in any other superhet design, for the reason that most of the signal amplification and selectivity is derived

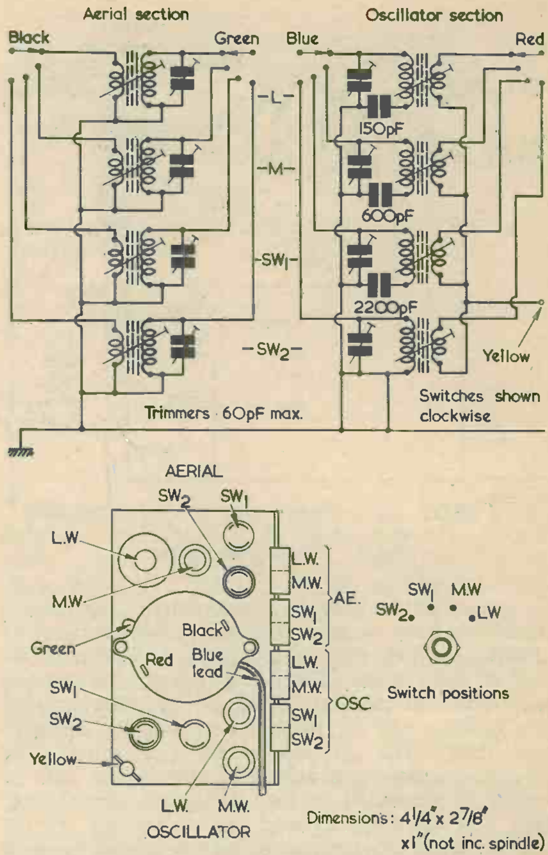


Fig. 2 (a). Circuit representation of the coilpack showing trimmer and padding capacitor values

(b). Layout of the coilpack showing the positions of individual coils, trimmer capacitors and colour coded connection points. Also shown are the wavechange switch positions

from it. With the single i.f. stage as shown, it is imperative to obtain high gain if overall satisfactory amplification is to be achieved. The circuit shown here fulfils these requirements.

Detector, A.G.C. and First Audio Stage

In this stage the EBC41 double-diode-triode has been specified. One diode (pin 5) is used for detection and the other diode (pin 6) for a.g.c. rectification. The triode section is utilised as the first a.f. amplification stage, this having an amplification factor of 40 to 50 times. With an a.f. gain of this order, which is rather more than that normally required, a reserve becomes available—a useful advantage when operating over the short wave ranges.

The circuit has been simplified as much as possible in order that beginners may successfully complete this stage. The cathode (pin 7) is taken to chassis by way of the bias components R_{15} and

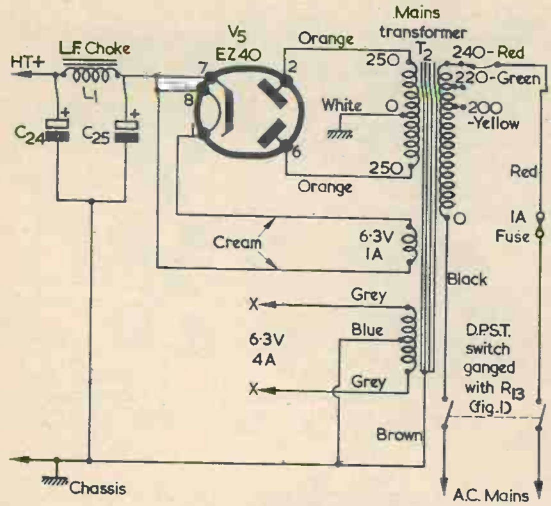


Fig. 3. Power supply circuit

C_{14}, the latter being an electrolytic component which must be connected in the correct manner as shown, positive end to the cathode and negative end to the chassis. On the actual component the lead-outs and marked + and − or, alternatively, the positive end is coloured red and the negative end black. The cathode is also wired directly to R_{13}, a variable potentiometer, the other end of which is connected to the i.f. bypass components R_{12}, C_{15} and C_{16}. From the centre tag of this potentiometer, C_{17} is connected directly to the grid (pin 3), from which electrode R_{14} is taken to chassis. The anode (pin 2) is supplied with h.t. potential via the two resistors R_{17} and R_{18}, from the junction of which C_{18} connects to chassis. The anode connects to capacitors C_{20} and C_{22}, the latter component acting as a bypass for any i.f. voltages that may still be present, while the former is the coupling component into the following stage.

The detector diode (pin 5) is connected directly to the i.f. transformer secondary winding as shown. The a.g.c. rectifying diode (pin 6) is connected to chassis via R_{16} and to the anode of V_2 via the coupling capacitor C_{19}. The a.g.c. time constant resistor R_9 also connects to pin 6 of V_3.

Output Stage

The output stage is built around the EL41, which is capable of delivering some 4 watts of audio to the speaker.

The grid (pin 6) is taken to chassis via R_{19}. The cathode (pin 7) is connected to chassis by way of R_{20} and C_{23} which together form the bias components. The screen grid (pin 5) is taken directly to the h.t. positive line. The suppressor grid (grid 3) is internally connected to the cathode. The anode (pin 2) connects directly to the output transformer primary winding, the other end of which carries on to the h.t. positive line. The capacitor C_{21} acts as a tone control. The speaker is fed from the secondary winding of the transformer, one side of which is connected to chassis.

The output transformer, as supplied, is complete with a colour code label giving full information on the correct connections. It does not matter which way round the secondary lead-out wires are connected to the speaker.

The foregoing, apart from the power supply about to be described, completes the general description of the basic receiver. It is a sound, well tried design, conforms to the valve manufacturers recommendations, and is one which the beginner can confidently commence to construct with every chance of success and confidence in the final outcome.

Those beginners requiring theoretical knowledge of the superhet, quite outside the scope of this article, are advised to obtain one of the many

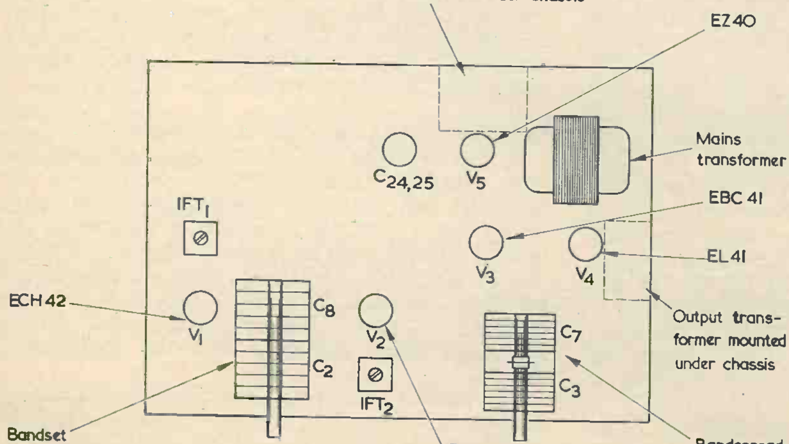


Fig. 4. Above-chassis main component layout

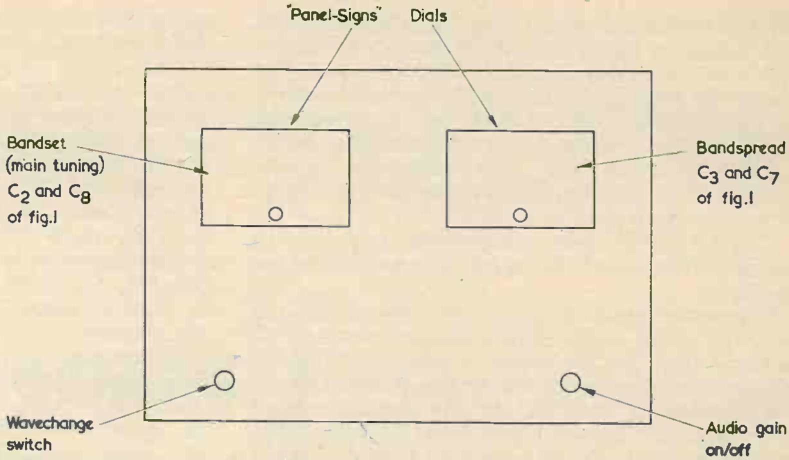


Fig. 5. Front panel layout showing simplicity of controls with the basic design

excellent publications now available on the bookstalls. One such book to be recommended is *Foundations of Wireless* published by Iliffe & Sons Ltd., and available direct from the Modern Book Company (see advertisements for address).

Power Supply

For those readers graduating from battery to mains powered receivers, this step is possibly one of the most fearsome of all. The "high voltages" may have a certain deterrent effect, but these need not unduly discourage the newcomer to a.c. mains equipment. Sooner or later, with progress through the hobby, the enthusiast must at some point make the change. In actual fact the danger is very slight if one reasonable precaution is taken. This is: never tinker with the receiver power supply, or the receiver itself, at any point in the circuit with the set connected to the a.c. mains. This means that the mains connecting plug must be withdrawn from the power socket whilst modifications, etc., are being carried out. Provided this simple precaution is carried out, no danger exists.

Fig. 3 gives the circuit of the power supply. The rectifying valve is the EZ40 which is sufficiently rated, together with the remainder of the components specified, to supply adequate power to the receiver complete with the modifications to be described in Part II of this series. The mains transformer is, in fact, somewhat over-rated, the type specified being included at the outset in order to cater for all later additions to the circuit. As such, it will run cool, however long the period of operation. Readers not wishing to proceed with the additions to be described in Part II can, of course, obtain a mains transformer having lower ratings than those specified here. In such a case, the h.t. current requirement would be 70mA and heater current requirement (for V_1 to V_4) 1.5A.

The switch shown in the a.c. mains supply to the power pack is incorporated with the volume control, R_{13}, of Fig. 1. A 1-amp fuse is included in the a.c. mains supply to the receiver.

The mains transformer has three a.c. mains input tappings which should be used according to the local voltage supply. All the transformer wires shown are colour coded so that no possible mistakes should occur when wiring up this part of the circuit. The transformer primary winding is fitted with four wires, these being the mains input tappings 240V (red), 220V (green), 200V (yellow) and 0V (black). The two input voltage tappings not used should be wrapped separately with insulation tape and tucked away alongside the transformer. The remaining tapping lead should be cut at some point along its length and wired to the 1A fuse, this being mounted on the chassis apron at a suitable point. The primary wiring should then be terminated at the switch on the rear of the volume control. From the other tags of this switch the mains input wiring should be taken through the rear of the chassis via a rubber grommet and thence to the mains plug itself. The brown wire, connected to the transformer screen, should be connected direct to chassis.

Dealing with the h.t. secondary winding, the two orange wires should be connected to the valveholder pins as shown, one to Pin 2 and the other to Pin 6. The white centre-tap should be connected direct to chassis.

The transformer is fitted with a separate heater winding supplying 6.3V at 1 amp for the rectifier

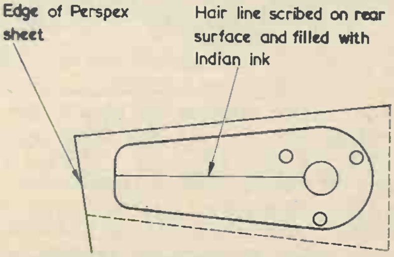


Fig. 6. Showing how cursors may be cut out and marked from a small sheet of Perspex

valve, the lead-out wires being cream coloured and connecting to Pins 1 and 8 of the EZ40. Pins 7 and 8 of the EZ40 are connected together. The remaining winding is that supplying heater current to V_1 to V_4, this being centre-tapped to chassis. The two grey wires should be terminated in a small tagstrip mounted near the transformer, heater supplies then being taken to the receiver valves from this tagstrip.

The l.f. choke (see Components List) is also conservatively rated in order to cater for later additions.

The power supply is entirely conventional and the inclusion of the mains transformer ensures that full isolation from the a.c. mains is achieved. The a.c. is converted to pulsating d.c. by the rectifier (EZ40), this then being smoothed by the capacitor input filter given by C_{25}, C_{24} and the l.f. choke. The heater supplies to the receiver itself should be taken to the respective valveholders via twisted wires. That is, the two heater leads must be twisted around each other, this considerably assisting in cancelling out any a.c. hum.

The cathode of the rectifier (pin 7) is taken to one wire of the l.f. choke (it does not matter which of the two choke wires is connected), the other wire of the l.f. choke then being taken to a tagstrip from which all h.t. positive potential for the receiver is taken. Connected to either side of the choke are the filter capacitors C_{24} and C_{25}. These two capacitors are contained within a single metal can and the whole assembly is mounted on the chassis by means of a metal clip. This fixing slip itself forms the earthing connection by virtue of being bolted to the chassis. The capacitor positive connections are clearly marked on the can itself, the actual tags being colour coded.

Provided the above paragraphs are carefully read in conjunction with the circuit of Fig. 3, the beginner need have no fear of trouble with his first power pack. For this reason, the circuit has been shown separately although it is, in fact, an integral part of the receiver itself.

Completed Receiver—First Stage

Having previously planned which form the receiver will finally assume, and the chassis and panel having been drilled and cut out to conform with such plans, wiring up of the receiver should now be commenced. All the information is contained in Fig. 1, including valveholder connections and those for the coil pack.

Having completed the receiver this far, carefully check all the wiring and connections, insert the rectifier valve EZ40, connect the plug to the mains supply and switch on. **Do not insert any other valve.**

Assuming a meter, even a simple one, to be available, the presence of h.t. voltages may be easily ascertained by connecting the meter, switched to the appropriate ranges, between the positive potential points and the chassis. This having proved satisfactory, switch off and **remove mains plug** from the socket. Do not allow the rectifier valve to run for any period of time longer than is necessary to carry out these simple tests. Next, insert the remainder of the valves into their respective valveholders, connect the aerial and earth and also the speaker. Insert the mains plug and switch on. All the valves will be seen to light up. A signal of some kind should then be tuned in. With the pre-aligned coilpack and i.f. transformers this should be a relatively easy matter provided the circuit has been correctly wired. The gain control should be turned to maximum (fully clockwise) and a weak signal selected. Carefully adjust the i.f. transformer cores in order to obtain the loudest response, repeating the process two or three times until no further improvements can be obtained. The coilpack should not be required to be touched, although slight adjustments are sometimes required to allow for circuit wiring and stray capacitances, etc.; in any event, these alterations should only be of a slight nature.

Having completed the foregoing, the reader is now in a position to add the further stages as, and when, time and available cash permit; these stages being described in Part II of this series.

Construction

Construction of the basic receiver largely follows commonsense lines, each stage following that preceding in an orderly fashion from the aerial input to the speaker output. The speaker is contained within a separate cabinet and the layout of the chassis is shown in Fig. 4.

No measurement details are given, these largely depending on the final form it is intended that the receiver should take. Generally speaking, a chassis measuring some 8 x 12 x 3in should be adequate for the complete design. This chassis depth is required in order to accommodate the coil pack specified and such a chassis may be obtained from the supplier—see Components List. Suitable panel dimensions for use with this chassis size are 14 x 9in.

The components should be laid out on top of the chassis as shown in Fig. 4, due attention being paid to the fact that all of the tuned circuit wiring should be as short and direct as possible. Lay out the components, bearing in mind that Part II of this series will contain details of an extra i.f. stage; b.f.o. stage; voltage stabiliser and a "magic eye" tuning indicator. The b.f.o. stage will be positioned alongside the bandspread capacitors, and the added i.f. stage between IFT_1 and V_3. The added stabiliser valve will be positioned between the ECH42 and the front panel, alongside the main tuning capacitor.

The next stage is to mark out the chassis and drill accordingly. Drilling details for the i.f. transformers are supplied with these components, whilst those for the valveholders will be self-evident.

Front panel details are shown in Fig. 5 and from this it will be seen that the two dials are taken from the Panel-Signs Set No. 6. Note should be taken of the measurements of these dials before drilling the front panel. The dials themselves are designed for self-calibration once the receiver has been completed, the various bands and known frequencies being calibrated and marked on the dial with indian ink or ordinary ball-point pen. In the latter case, the amateur bands may be marked with a red and the broadcast bands with a black colour, thereby imparting to the dial an attractive finish. Once calibration has been completed, the whole area of the two dials may be covered with small sheets of clear Perspex, this protecting them from damage and dust. Two pointers may easily be made of the same material, hair lines being scribed and filled in with indian ink as shown in Fig. 6.

The front panel of Fig. 5 is that of the basic design only, and more controls will be added as the additions to be described in Part II proceed. These added controls will consist of a.g.c. on/off switch, i.f. gain, tone, audio filter, b.f.o. switch, b.f.o. pitch control and phone socket.

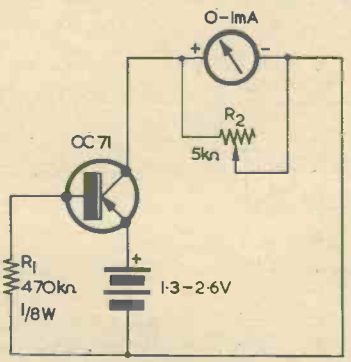
(To be continued)

Transistorised Thermometer

by Carlton D. McVey

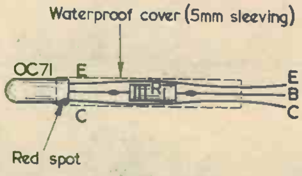
An intriguing application for the ubiquitous OC71

HAVE YOU EVER TAKEN YOUR TEMPERATURE WITH a clinical thermometer, and spent valuable time trying to locate the elusive mercury column? The type of thermometer suggested here saves unnecessary time and eyestrain. It takes advantage of the thermal instability of the well-known OC71, which changes resistance when heat is applied.



This causes more collector current to flow which, in this particular circuit, shows as a reading in the meter. See Fig. 1.

Good thermal contact with the transistor shell will raise the reading from 0.1mA to about 0.8mA. The constructor, after building the unit, should calibrate it against a standard mercury column thermometer and mark the graduations on the meter scale. The preset meter shunting resistor R_2 can be adjusted to set the "normal" reading (98.4°F) at a convenient point on the scale. The transistor should be placed under the tongue to obtain good thermal contact, and a suitable method of construction is shown in Fig. 2.



For an attractive variation the paint can be scraped from the transistor shell, thus enabling the meter to be used for detecting infra-red radiation or, in photography, as a light meter. This assumes an old type OC71 without a metal case—alternatively an OCP71 phototransistor can be used.

10th International VHF/UHF Convention

The 10th International VHF/UHF Convention will be held on Saturday, 16th May, 1964, at Kingsley Hotel, Bloomsbury Way, London, W.C.1.

The programme will be as follows: Morning, exhibition of trade and amateur products; afternoon, programme of lectures having a wide interest to all v.h.f./u.h.f. enthusiasts; evening, dinner and presentation of prizes.

Tickets may be obtained from the VHF/UHF Convention Treasurer, F. E. A. Green, G3GMY, 48 Borough Way, Potters Bar, Middlesex. Convention only, 3s. 6d.; convention and dinner, 27s. 6d.

3-Transistor Intercom

FRANK G. EDWARDS

THE THEORETICAL CIRCUIT FOR THE INTERCOM system described in this article is given in Fig. 1. As may be seen, three transistors are employed in cascade, Talk-Listen switching being effected by S_1.

Components

Component values are not critical and Red Spot transistors for TR_1 and TR_2, and Yellow/Green Spot for TR_3 may be used. However, for better results the Mullard transistors OC71 and OC72 should be employed for $TR_{1,2}$ and TR_3 respectively.

As the input is at low impedance, unscreened wire to the remote point may be fitted. Quite long distances are possible, and the unit can be used between any two rooms in a house.

The two speakers were each 3Ω units, both acting as microphone and loudspeaker. The two transformers each had a ratio of 10:1 (i.e. 300Ω to 3Ω impedance).

Although a larger speaker was possible the author used a 3in type in the unit containing the amplifier. A 6 x 4in speaker was employed at the remote position.

Initially, the amplifier was powered by an Ever-Ready PP3 battery, but a power unit giving 9 volts and running from the mains was later substituted. Since the intercom was in operation for relatively long periods of time this was found to be more economical.

This system uses only one amplifier, with the result that the person at the amplifier end can call the other but, unless the unit is left on all the time, he cannot be called. If a simple buzzer is used this difficulty is overcome, as shown in Fig. 1. When the person at the amplifier end wishes to call the second person he ensures that his switch is in the talk position, and calls him up via the remote loudspeaker. When the second person wishes to call the person at the amplifier end he presses the buzzer and waits until he hears an answer. A bulb or bell might also be used. The positive supply lead is employed as one of the leads to the buzzer, and thus only 3-core cable is necessary, the first core being from contact 4 on switch S_1, the second being the lead common to the positive supply line and the buzzer battery, and the third connecting to the buzzer. The buzzer can be fitted together with a small battery to the side of the amplifier cabinet.

Another way of overcoming the difficulty is to

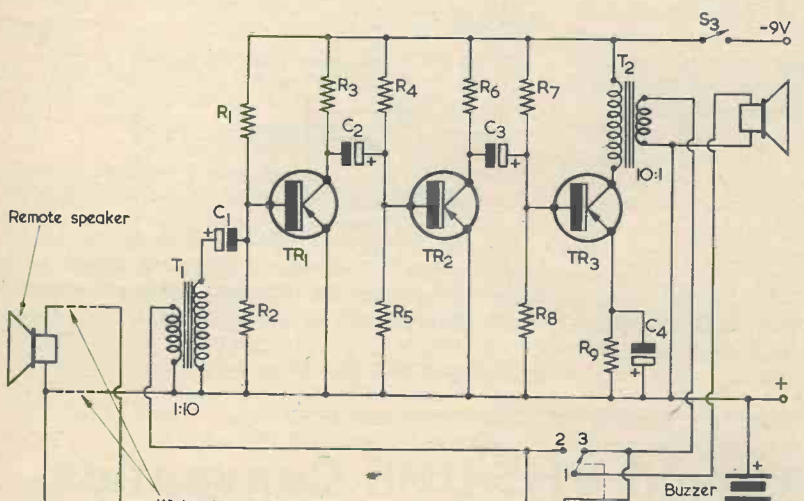


Fig. 1. The circuit of the 3-transistor intercom system

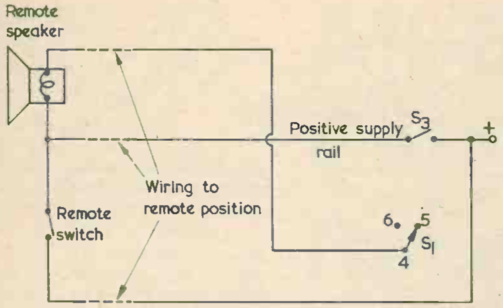


Fig. 2. An alternative method of providing calling facilities from the remote position. S_3 is now in the positive supply line

supply the person at the remote end with a switch in parallel with the on/off switch S_3, so that he may turn on the amplifier and make the call when he wishes. In this case, the person at the amplifier end must always remember to leave the unit in the Listen position when it is not in use.* The on/off switch S_3 would now have to be in the positive supply lead to the amplifier and the three wires to the remote speaker would be as follows: the first from number 4 on switch S_1, the second from the positive supply lead after S_3, and the third from the positive supply lead before S_3. (See Fig. 2.)

Components List
(Fig. 1)

Resistors
(All 10% ¼ watt)
R_1 220kΩ
R_2 22kΩ
R_3 47kΩ
R_4 220kΩ
R_5 22kΩ
R_6 47kΩ
R_7 18kΩ
R_8 10kΩ
R_9 120Ω

Capacitors
C_1 2μF electrolytic 6V wkg.
C_2 2μF electrolytic 6V wkg.
C_3 2μF electrolytic 6V wkg.
C_4 50μF electrolytic 6V wkg.

Transistors
TR_1, TR_2 OC71 or Red Spot (see text)
TR_3 OC72 or Yellow/Green Spot (see text)

Switches
S_1 d.p.d.t. switch
S_2 s.p.s.t. push-to-make switch
S_3 s.p.s.t. switch

Transformers
T_1, T_2 10:1 (transistor output transformers would be suitable)

Batteries
9 volt battery (if used—see text)
3–6 volt battery (to suit buzzer)

Miscellaneous
2 speakers, 3Ω (see text)
1 buzzer
8-way tagboard (8 pairs)
Terminals, case, etc.

Construction

The author built the amplifier and the speaker into a box which measured 12 x 7½ x 3in deep. The back panel overlapped by ¾in at each side and had two holes at each top corner, as shown in Fig. 3, to hook on to two nails in the wall.

The amplifier was built on an 8-way tagboard, this being bolted to the front panel at the left of the speaker. See Fig. 4. Below the tagboard were fitted the transformers and, in the centre, switch S_1. The battery (if used) can be held in a clip at the bottom right hand corner.

The components should be assembled to the tagboard first, long leads being left to make connection with the transformers and the battery or power unit. The tagboard assembly, together with the speaker, switches, sockets and output and input transformers, should then be bolted to the front panel of the box and finally wired up.

Before switching on or connecting up the supply, the wiring should be checked against the circuit diagram. If the wiring is then found to be correct the unit should be tested.

* The Talk-Listen switch could, alternatively, be of the spring-loaded type, returning automatically to the Listen position when released.—EDITOR.

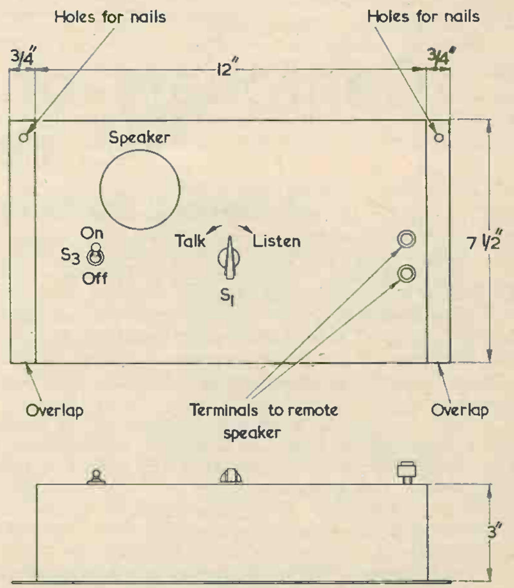


Fig. 3. The general appearance and outside dimensions of the amplifier case

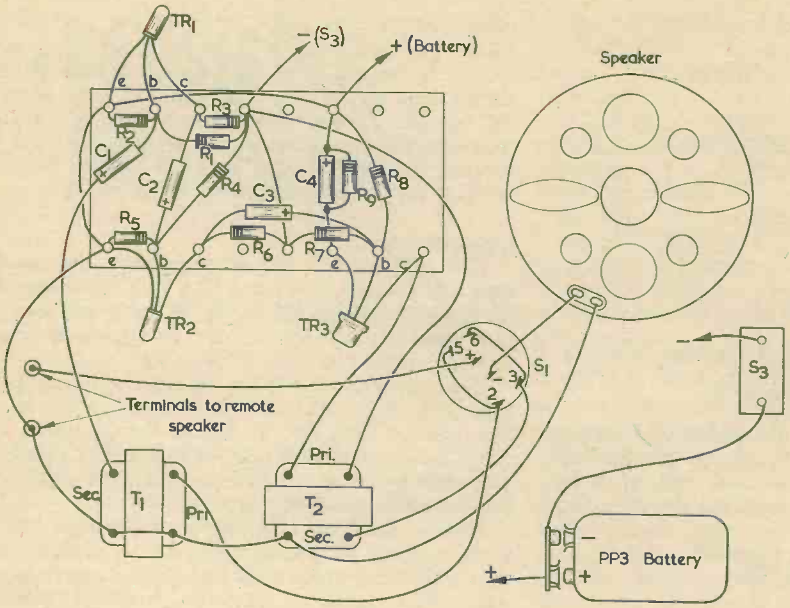


Fig. 4. Internal layout of the amplifier case looking at the back of the front panel. Note that transformers T_1 and T_2 are mounted with their cores at right angles to each other. The buzzer and buzzer battery of Fig. 1 are not shown here, these components being mounted outside the case

The system should work first time; if not, the wiring should be checked for dry joints. When everything is operating correctly the back panel can be screwed to the box and hooked on to the wall as described.

The author covered the whole of the front panel with speaker fabric and the sides with Fablon. Alternatively, the speaker aperture only could be covered with fabric, and the whole of the box with Fablon.

If there is any tendency towards instability in the amplifier, it may be helpful to connect a 50 or 100μF capacitor across the supply lines after S_3.—EDITOR.

Centenary of S. Z. De Ferranti

(1864—1930)

A Special Exhibition at the Science Museum

This year marks the centenary of the birth of S. Z. de Ferranti, pioneer of the use of electric power.

The Museum is commemorating the occasion in two ways: a special exhibition is being held, and a Science Museum booklet is being published giving an account of some aspects of S. Z. de Ferranti's work.

The exhibition will be opened at 11 a.m. on 9th April, the day of Ferranti's birth, by his grandson, Sebastian Z. de Ferranti. It will remain open until 31st August.

Members of the press are most welcome to attend the opening and to have prior view of the exhibition earlier that morning, or by appointment. They can also be sent, on receipt of an application, a copy of the booklet mentioned above.

S. Z. de Ferranti is perhaps best known for his Deptford scheme of 1890 for the supply of electricity; for it can be said that the power station at Deptford, which was part of this scheme, was the forerunner of the modern power station. The circumstances which governed the choice of site at Deptford were much the same as those deciding the placing of a thermal power station today: land was available and reasonably priced, cooling water was plentiful and coal could be readily delivered. Ferranti planned to install generating plant with an ultimate capacity of 120,000 horse-power, sufficient to light the whole of London, and to carry the current to substations in London at the then unheard-of pressure of 10,000 volts.

Dr. Ferranti is also automatically associated with the invention and manufacture of electrical equipment; in particular generating equipment and transformers and the schemes incorporating them. An account of this side of his work is, of course, given in both the exhibition and the booklet, and drawings from Ferranti's own sketch books are used to illustrate it. But, in addition, something of his lesser-known work on steam engines, turbines and cotton spinning is also shown.

Cover Feature

All-Band Communications Receiver

by R. MURRAY-SHELLEY

This article describes an ambitious communications receiver which may be built by the more experienced constructor. As is explained in the text, the design employs some unusual features, including panel trimmers for both the aerial and r.f. tuning circuits

SERIOUS SHORT WAVE LISTENING REQUIRES THE USE of a receiver whose sensitivity and selectivity are somewhat above those of the average domestic superhet. Further, specialised facilities are required such as, for example, a beat frequency oscillator to allow reception of unmodulated carrier wave signals. Many of these facilities are incorporated in the receiver described in this article. The circuit is adaptable and alternative circuitry has been shown where appropriate.

Design Features

Perhaps the foremost problems which confront the designer of circuits such as this are those of sensitivity and selectivity. In addition the maintenance of low noise levels throughout the circuit is of paramount importance.

Referring first to the question of sensitivity, it was decided to employ an r.f. stage in addition to two stages of i.f. amplification. The valve type used in all these stages is the 6BA6 which has a characteristically high gain, whilst at the same time generating little noise.

Tuning the r.f. amplifier introduces additional selectivity as well as additional gain into the circuit. No i.f. filter was fitted in the prototype since coverage of the broadcast (long and medium) wavebands was incorporated, and too much selectivity would result in a drastic loss of audio quality.

The choice of the intermediate frequency in single superhet receivers of this kind must always be something of a compromise. A high frequency such as 1.6 Mc/s favours good image rejection which is particularly important at high frequencies, while a low frequency results in good adjacent channel selectivity though poor image rejection. Accordingly, the standard frequency of 465 kc/s was chosen, thus striking a balance between the factors mentioned.

The Circuit

The circuit diagram is shown in Fig. 1. A coil turret is employed, this offering a particularly efficient method of band-switching which eliminates many of the switching losses associated with conventional coil packs. The turret as supplied covers the frequencies 1.5 to 30 Mc/s in three bands, (1.5–4 Mc/s; 4–12 Mc/s; 10–30 Mc/s). In addition, separate coil strips may be purchased covering the long and medium wavebands for incorporation in the turret.

The signal received at the aerial passes via C_1 to the aerial coils which are tuned by $VC_{2(a)}$. Panel mounted trimmers are employed in conjunction with both the aerial coils and the mixer coils. The reason for this is that accurate alignment over the whole of a band is not normally possible with pre-set trimmers unless a very high quality tuning capacitor is employed. A pre-set trimmer is used in the circuit associated with the local oscillator.

The amplified signal from the r.f. stage is passed to the second stage, the frequency changer. A single triode-hexode is used as a combined mixer and oscillator. The usual objection to the use of a single valve as a frequency changer is that the oscillator frequency may be "pulled" by strong signals, though no serious problems have arisen in the prototype due to this cause. The output from the frequency changer is at a frequency of 465 kc/s, and the signal is now amplified by the two i.f. amplifiers. As previously mentioned, no i.f. filter was employed

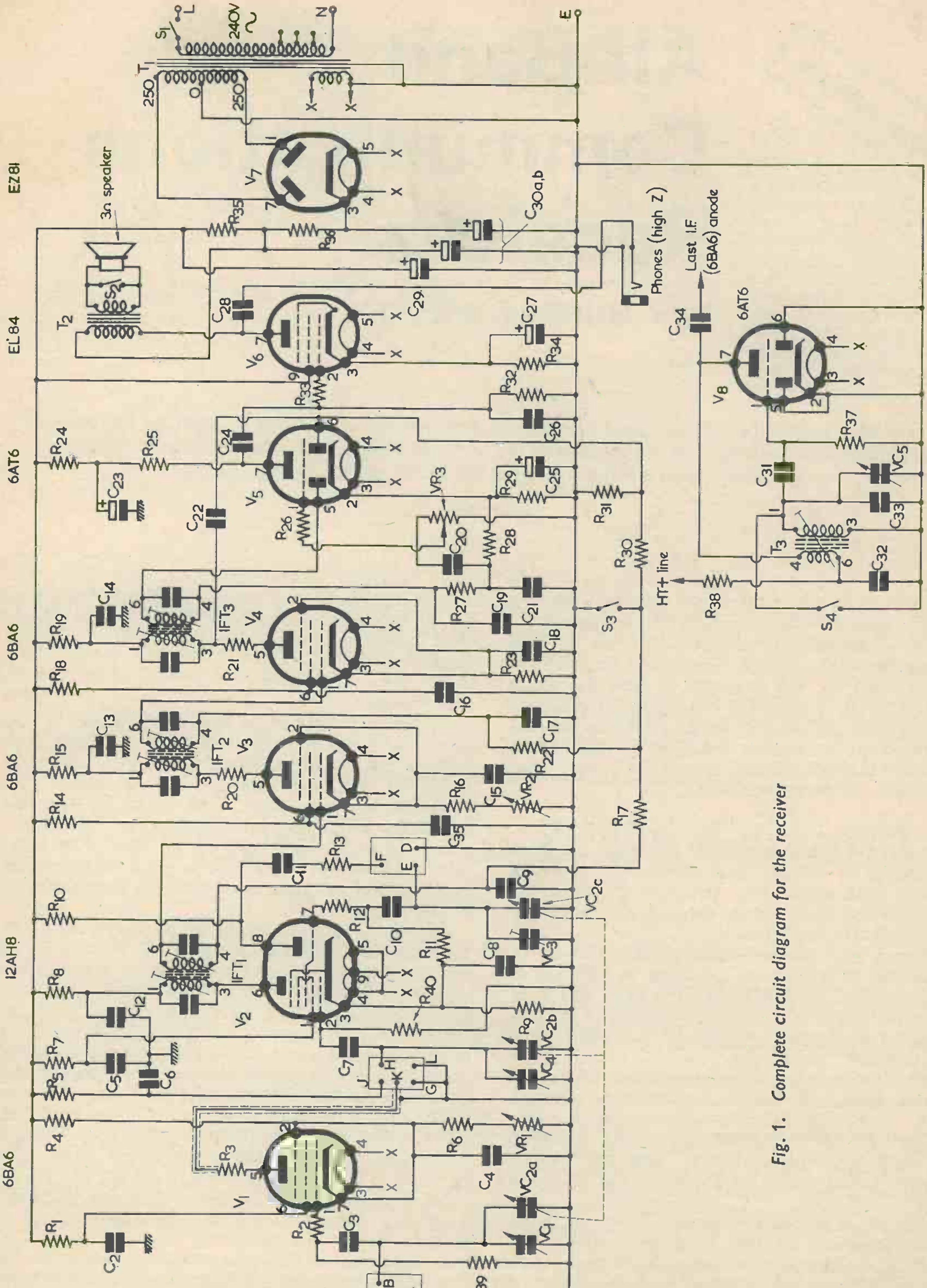


Fig. 1. Complete circuit diagram for the receiver

Components List

Resistors

(All 10% ½ watt unless otherwise specified)

R_1	33kΩ
R_2	10Ω
R_3	10Ω
R_4	100kΩ
R_5	1kΩ
R_6	68Ω
R_7	33kΩ
R_8	1kΩ
R_9	220Ω
R_{10}	33kΩ
R_{11}	47kΩ
R_{12}	10Ω
R_{13}	150Ω
R_{14}	33kΩ
R_{15}	1kΩ
R_{16}	68Ω
R_{17}	100kΩ
R_{18}	33kΩ
R_{19}	1kΩ
R_{20}	10Ω
R_{21}	10Ω
R_{22}	100kΩ
R_{23}	68Ω
R_{24}	47kΩ
R_{25}	220kΩ
R_{26}	6.2kΩ
R_{27}	47kΩ
R_{28}	220kΩ
R_{29}	3.3kΩ
R_{30}	1MΩ
R_{31}	1.8MΩ
R_{32}	470kΩ
R_{33}	2.2kΩ
R_{34}	150Ω 1 watt
R_{35}	500Ω 5 watt
R_{36}	500Ω 5 watt
R_{37}	47kΩ
R_{38}	47kΩ
R_{39}	220kΩ
R_{40}	220kΩ
VR_1	25kΩ pot. lin.
VR_2	25kΩ pot. lin.
VR_3	1MΩ pot. log.

Capacitors

C_1	250pF ceramic
C_2	0.1μF, paper, 500V wkg.
C_3	100pF ceramic
C_4	0.1μF paper 250V wkg.
C_5	0.1μF paper 500V wkg.
C_6	0.1μF paper 500V wkg.
C_7	100pF ceramic
C_8	0.1μF paper 250V wkg.
C_9	0.05μF paper 250V wkg.
C_{10}	50pF silver mica
C_{11}	200pF silver mica
C_{12}	0.1μF paper 500V wkg.
C_{13}	0.1μF paper 500V wkg.
C_{14}	0.1μF paper 500V wkg.
C_{15}	0.1μF paper 250V wkg.
C_{16}	0.1μF paper 500V wkg.
C_{17}	0.05μF paper 250V wkg.
C_{18}	0.1μF paper 250V wkg.
C_{19}	100pF ceramic
C_{20}	0.02μF paper 500V wkg.
C_{21}	100pF ceramic
C_{22}	50pF ceramic
C_{23}	16μF electrolytic 350V wkg.
C_{24}	0.02μF paper 500V wkg.
C_{25}	25μF electrolytic 12V wkg.
C_{26}	50pF ceramic
C_{27}	100μF electrolytic 25V wkg.
C_{28}	0.02μF paper 1kV wkg.
C_{29}	16μF electrolytic 350V wkg.
$C_{30(a)\ (b)}$	32+32μF electrolytic 350V wkg.
C_{31}	100pF ceramic
C_{32}	0.1μF paper 500V wkg.
C_{33}	140pF silver mica
C_{34}	5pF ceramic (see text)
C_{35}	0.1μF paper 500V wkg.
VC_1	25pF panel trimmer
$VC_{2(a)\ (b)\ (c)}$	315pF 3-gang
VC_3	30pF concentric trimmer
VC_4	25pF panel trimmer
VC_5	15pF panel trimmer

Coil Turret

Coil turret type CT7/B (Denco). With additional coil strips covering medium and long waves if required.

Inductors

$IFT_{1\ 2\ 3}$	I.F. transformers, 465 kc/s, type IFT11 (Denco)
T_1	Mains transformer. Secondaries 250–0–250V at 100mA, 6.3V at 3.5A (minimum). Weyrad E822 would be suitable
T_2	Output transformer, ratio 40:1
T_3	B.F.O. coil, 465 kc/s, type BFO2 (Denco)

Valves

V_1	6BA6
V_2	12AH8
V_3	6BA6
V_4	6BA6
V_5	6AT6
V_6	EL84
V_7	EZ81
V_8	6AT6

Sockets

1 phone jack
1 aerial socket
1 earth socket
5 B7G valveholders with screens
1 B9A valveholder with screen (for V_2)
2 B9A valveholders without screens

Switches

S_1–S_4 s.p.s.t. toggle switches

Speaker

3Ω impedance

Miscellaneous

Aluminium for chassis and case. (Prototype used aluminium case type "Y", 15 x 9 x 7in (H. L. Smith & Co., Edgware Road)
Tuning capacitor drive and scale
Knobs
Connecting wire, etc.

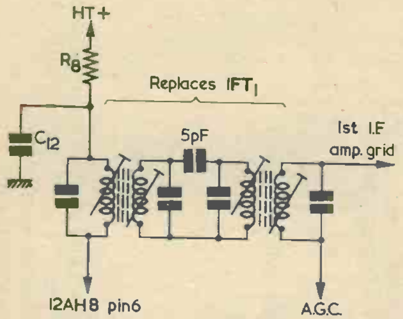


Fig. 2. A filter circuit which could replace IFT_1

in the prototype, though additional selectivity may be secured if such a filter is fitted. A simple, though none the less effective, filter can consist of two i.f. transformers connected back-to-back as shown in Fig. 2. This filter may be inserted in place of IFT_1. A loss of signal strength will occur, however, if such a filter is included.

A 6AT6 double-diode-triode valve acts as demodulator, a.g.c. rectifier and audio amplifier.

The A.G.C. System

An effective a.g.c. system of the delayed type is incorporated in this circuit. A.G.C. voltages are applied only to the i.f. amplifiers and not to the r.f. stage since this could adversely affect the signal to noise ratio. Neither is a.g.c. applied to the frequency changer since this could detract from its efficiency. To avoid overloading of the r.f. stage and the i.f.

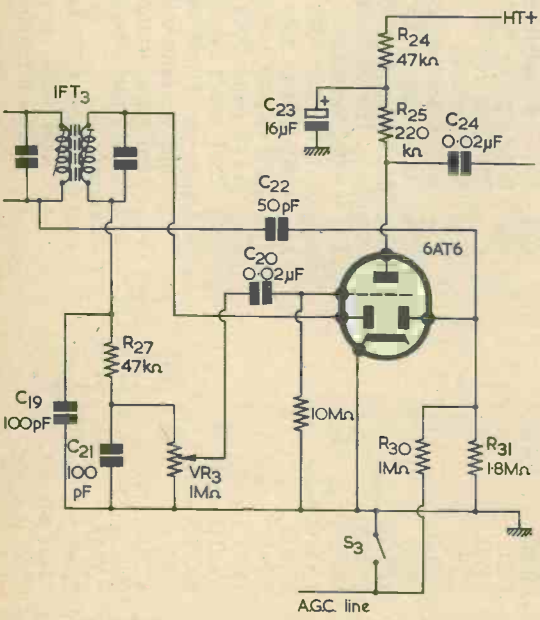
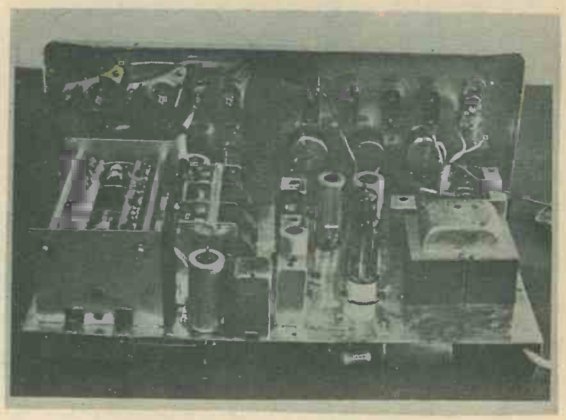


Fig. 3. A modified detector circuit which gives direct a.g.c.



Rear view of the writer's receiver

strip on very strong signals, manual gain controls are fitted in the cathode circuits of the r.f. valve and the first i.f. valve.

As mentioned above, the a.g.c. is delayed. This means that the a.g.c. system will only commence to operate with signals above a certain level, full sensitivity being retained for very weak signals. The delay voltage is produced across the cathode resistor R_{29}, of the 6AT6, (V_5.) No a.g.c. voltage can be produced until the signal on the a.g.c. diode exceeds the voltage across R_{29}, i.e. exceeds the cathode voltage.

The one drawback to this form of delayed a.g.c. concerns the use of tuning meters. A tuning meter is normally inserted in such a manner that its operation is dependent on the a.g.c. operation. Such a meter would, therefore, not give a reading on very weak stations when the a.g.c. system would be inoperative. If the inclusion of a tuning meter is contemplated it might be worthwhile incorporating a direct a.g.c. system; that is, a system which operates on all signals irrespective of their level. A modified circuit giving direct a.g.c. is shown in Fig. 3.

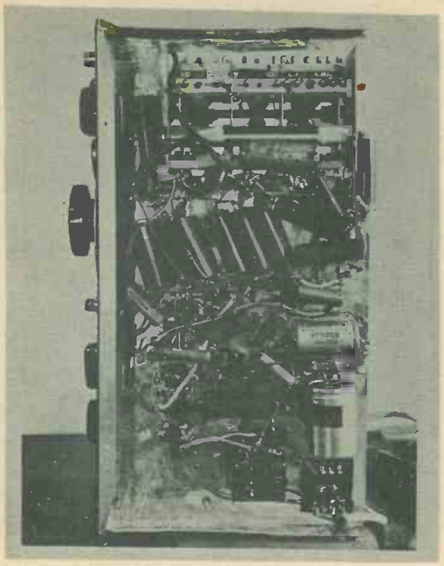
A switch is incorporated (in both Fig. 1 and Fig. 3) which short-circuits the a.g.c. line and renders the system inoperative. This can be useful when receiving c.w. transmissions since, otherwise, the a.g.c. system might try to follow the morse signals.[1] Normally the system is left switched on (S_3 open).

The audio output stage is conventional, a high slope EL84 being employed. Good h.t. smoothing ensures that no hum is discernible on the output. The power supply is conventional.

Provision for high impedance headphones is made, a signal being extracted via C_{28}. The internal loudspeaker may be short-circuited by S_2 when phones are employed.

A beat frequency oscillator is included in the design. The theory of the b.f.o. is well known. It

[1] It may be possible, also, for the output from the b.f.o. to cause an a.g.c. voltage to be developed which reduces receiver sensitivity to weak signals.—EDITOR.



The components under the chassis

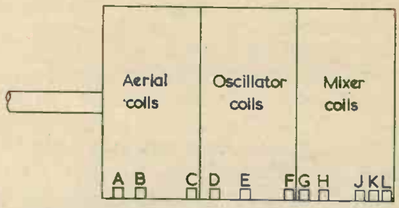


Fig. 4. The connections to the coil turret. The letter designations agree with those given in Fig. 1

is an oscillator tunable to about 2 kc/s either side of the i.f. (i.e. tunable, here over the range 463 to 467 kc/s). When the signal from the b.f.o. is mixed with the signal at the intermediate frequency, a beat note whose frequency is the difference between the i.f. and the b.f.o. frequency is produced, thus rendering unmodulated c.w. transmissions audible. The b.f.o. may also be used to supply the missing sideband and make s.s.b. (single side band) transmissions intelligible. The b.f.o. is turned on and off by S_4, which short-circuits the tuned winding on the b.f.o. coil. This switching method is preferable to that normally employed (viz. fitting a switch in the anode circuit), since it means that the valve is not left for long periods without an anode potential—such a practice could "poison" the cathode.

Depending on the layout, C_{34} may not be required, sufficient pick-up being obtained by strong radiation from the b.f.o. circuit. The pitch of the beat note produced is controlled by VC_5.

Components

In general there is a fairly wide tolerance permissible in most of the component values. This tolerance does not apply, however, to the components associated with the oscillators or the various tuned circuits. Decoupling capacitors such as C_2 have been given a nominal value of 0.1μF. Any value above about 0.05μF can, however, be used. Carbon composition resistors are employed in almost all cases though these should, if possible, be new to ensure that they will generate little noise.

No electrical bandspread has been fitted, reliance being placed on a very good quality slow motion drive. A three gang bandspreading capacitor could, nevertheless, be fitted. A suitable value would be about 25pF each section.

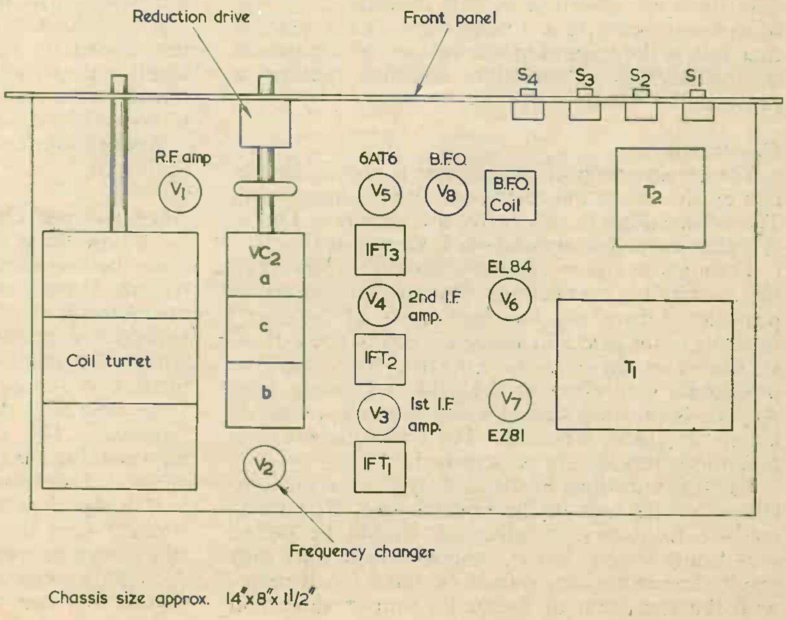


Fig. 5. A suggested above-chassis layout for the major components

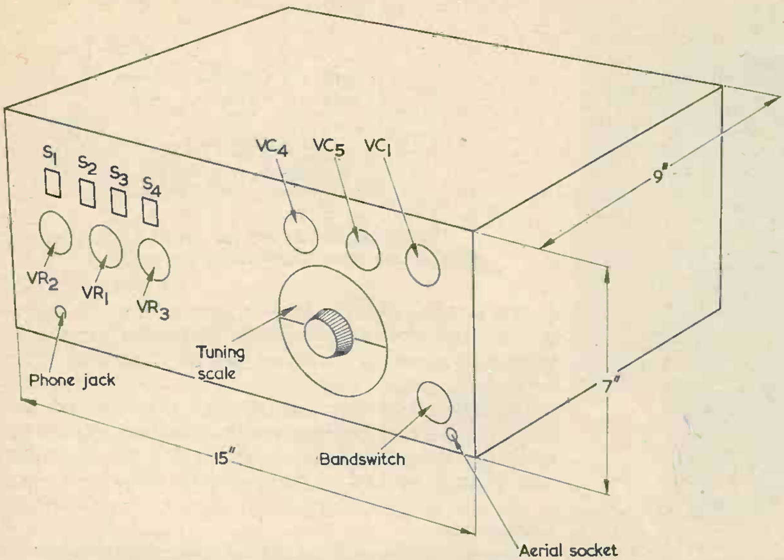


Fig. 6. A suggested front panel layout

The question of the tuning dial assembly calls for some comment. In the prototype a plain dial calibrated 0–100 was used in conjunction with a vernier scale. It is felt that this type of dial makes alignment easier than does the type already calibrated in terms of frequency. Indeed, calibration may be more accurate in the long run if a plain dial is used, since accurate calibration graphs can be drawn between the scale readings and frequency, a signal generator being used to provide calibration points.

Individual constructors always, and quite rightly, have their own ideas on equipment housing. The prototype was built into an aluminium case obtainable from an advertiser in this magazine, the size of this case being 15 x 9 x 7in high. It is suggested that this is the minimum size of case which should be considered. Panel-Sign transfers ensure a professional finish.

Construction

The construction of the receiver is greatly simplified by the use of the coil turret already mentioned. The connections to this turret are shown in Fig. 4. A suggested component layout is shown in Fig. 5.

Throughout the receiver it is essential to keep all signal-carrying connections absolutely as short as possible. Liberal use has been made of "stopper" resistors in the grid and anode circuits of the various stages. For these to be effective they must be positioned very close to the grid and anode tags. Any leads carrying signals which are of appreciable length should be screened. The connections to the potentiometers should be screened.

Earth connections in the prototype were made to chassis solder tags in the normal way. The intermediate frequency transformers should be bolted very firmly to the chassis, otherwise instability may result. Screening cans should be fitted to all valves with the exception of the audio output valve and the h.t. rectifier. If long leads are found to be necessary when connecting to the tuning capacitor VC_2, these should be screened, coaxial cable being used.

The chassis in the prototype was home made from sheet aluminium, and was about 14 x 7 x 1½in in size. A commercially made chassis could, of course, be used.

An internal speaker of 6½in diameter was fitted to the prototype. With such a speaker fitted inside the receiver case, made as it is of metal, care must be taken to ensure that everything is mechanically solid and stable otherwise cnnoying vibrations and buzzes will result. There might also be feedback to the tuning capacitor.

If additional coil strips are purchased to enable the receiver to cover the long and medium wavebands, care should be taken when fitting them into the turret to ensure that the fine wire connections to the coils are not damaged.

A suggested layout for the front panel is shown in Fig. 6.

Alignment and Operation

The coil turret used in the prototype was supplied with the coil cores pre-aligned, thus saving much trouble. In any event the first step in the alignment procedure is to align the i.f. amplifier. If a signal generator is available this should be set to 465 kc/s with a.f. modulation switched on, and a signal injected at the mixer grid. An output meter (or a valve voltmeter connected across R_{28}) will also be required. The i.f. transformer cores are then adjusted for maximum output starting with IFT_3 secondary and ending with IFT_1 primary.

If a signal generator is not available the transformers may be aligned by ear assuming a local station can be received, as will probably be the case. A slightly more accurate method which does not require the use of a signal generator consists of connecting a high resistance voltmeter (at least 10,000 ohms per volt) between the a.g.c. line and the chassis. (Connect the positive side of the meter to the chassis). Now tune in a local station and adjust the i.f. transformer cores for a maximum reading on the meter. Note that on local stations in the medium and long wavebands the a.g.c. voltage can exceed 80. The a.g.c. system should of course be switched on during this process.[2]

Once the i.f. strip has been aligned, and assuming that a plain dial has been employed and that the coil turret has been supplied pre-aligned, little more remains to be done. The receiver should now be capable of receiving many stations, and the oscillator trimmer should be set to some arbitrary position about midway through its range. Final peaking of the signal can then be carried out using the panel trimmers.

If a dial already marked in terms of frequency or wavelength is to be employed, then the alignment procedure is more complicated. The i.f. strip should be aligned as before, though now a signal generator should be used and the i.f. set to 465 kc/s exactly.

Next tune to the highest frequency band and inject a signal near its low frequency end at the mixer grid. Set the tuning capacitor VC_2 such that this frequency is shown on the receiver dial and adjust the oscillator coil core to receive the signal. Now tune to the top end of the band and repeat the process, this time adjusting VC_3. Repeat a similar process for all bands. Next inject the signals at the r.f. stage, and align the mixer coils in a similar manner. Finally align the aerial coils by injecting the signal at the aerial. Notice that VC_1, VC_3 and VC_4 are all aligned at the upper frequency end of the 10–30 Mc/s band.

The receiver aerial input circuits are designed to match into a long wire end-fed aerial which should, of course, be as high as possible. Changes in the aerial system will usually involve adjusting the panel aerial trimmer VC_1.

Finally check the operation of the b.f.o. The core of the b.f.o. coil should be adjusted such that the b.f.o. oscillates at the intermediate frequency with the pitch control, VC_5, at about the centre of its range.

[2] In the present circuit, the secondary of IFT_3 does not enter the a.g.c. loop. Whilst all other i.f. windings may be aligned against a.g.c. voltage, IFT_3 secondary will need to be aligned for maximum a.f. output.—EDITOR.

RADIO TOPICS . . .

by Recorder

As regular readers may be aware, I tend to get involved every now and again in the odd bit of spare-time servicing for friends and acquaintances. So far as radio receivers are concerned, I don't object to these occasional jobs. If the truth be told, indeed, I enjoy doing them, because the faults are usually fairly simple to clear and it isn't too difficult to obtain any spare parts that are needed for replacements. Also, I obtain a certain feeling of accomplishment after getting a recalcitrant radio back into working order again.

My reactions towards TV receivers are, however, very different. In my opinion, the only sensible way of dealing with a TV repair which involves anything more complicated than changing a valve is to tackle it in a correctly fitted-out service workshop with plenty of spare parts on hand. Without suitable servicing facilities one can spend hours chasing a snag which could be located within five minutes in a proper workshop. I have a fairly busy day and, apart from doing TV jobs for close relatives and the like, I find that I begrudge wasting time needlessly in this manner. There is also the risk that the set is suffering from a faulty vertical output transformer or deflection yoke, or any similar component which is difficult to replace other than through the manufacturer's service depots. So, when an acquaintance drops a hint about the shortcomings of his TV I maintain a wary silence, and hope it will all blow over soon.

Despite this watchfulness I have still been caught in the past by one or two of those characters who are on the lookout for favours on the cheap, and I have always been fascinated by the manner in which they minimise the symptoms when introducing the subject. "It only requires a slight adjustment, old boy," they'll say soothingly. Whereupon, if you *do* take a look at the set, you'll find a completely blank screen, a burnt-out line output transformer and half the valves missing. But once you've carried out the symbolic act of removing the back to discover these facts, boy, you're hooked!

For the benefit of newcomers to this little social hazard, I thought it might be helpful to prepare a short glossary of phrases employed by TV set-owners to describe the defects in their receivers, together with what you will actually find if you are persuaded to undertake their repair.

Cause and Effect

Complaint. "It's just a loose screw."

Actual fault. Junior has managed to pull off the channel selector knob and has carefully pushed back all the oscillator slugs, breaking off the internal coil former threads in the process.

Complaint. "There's a faint flicker every now and again."

Actual fault. The picture is completely lost under continual white flashes resulting from a fantastic firework display in the line output cage. For the last six weeks they've had to keep all the doors and windows open to disperse the smell of corona.

Complaint. "It's only a loose wire."

Actual fault. A supply lead came adrift from the tuner unit and clever Uncle Harold, in an attempt at repair, has broken three feed-through capacitors, snapped off the fine tuning vane, dropped a great blob of solder all over the top and into the pins of the cascode valve-holder, and has lost all the tuner mounting bolts, which are 5BA and unobtainable locally.

Complaint. "There's a funny smell of scorching."

Actual fault. Grandma airs her nighty by hanging it over the top and back of the set.

Complaint. "I think it's the little valve near the back of the set."

Actual fault. This complaint represents a very cunning ploy which must always be regarded with the greatest suspicion. When you approach the valve you will find that it has a top cap which has come away from the glass in its connecting clip. *They* knew that all the time, but they have craftily stuck it back on again with Plasticine. So, when the top cap comes off in *your* hands, it's all your fault.

Complaint. "We don't seem to be able to get BBC-2."

Actual fault. Receiver was manufactured in 1946.

Complaint. "We just thought we'd have the valves tested."

Actual fault. This is Uncle Harold again. After pestering someone to let him use a valve tester, he's replaced all the valves in the wrong holders. His greatest difficulty was getting B9A valves into B7G sockets, and vice versa, but he's succeeded.

Complaint. "The sound seems a little weak."

Actual fault. Baby has emptied potty into loudspeaker grille.

Comparative Chassis Testing

Turning towards the more serious aspects of servicing, I was interested to note recently that a service manager friend of mine occasionally falls back on what I remember as a war-time dodge whenever he is faced with a particularly elusive snag in a television receiver.

During the war, a lot of my time was spent in the repair and maintenance of v.h.f. aircraft transmitter-receivers, and the only servicing aids we had were a multi-testmeter and a unit which comprised a crystal-controlled signal generator giving an output at aerial frequency plus a meter for lining up the transmitter section. Occasionally, we bumped into snags which were difficult to locate with these instruments.

If we had run out of ideas on a particular fault, our final approach was to take another transmitter-receiver known to be good and set it alongside the faulty one. We then connected the two chassis together with a crocodile clip lead and took comparative resistance readings to chassis around the suspect stage or stages in the two sets. To take a very simple example (and one which, really, wouldn't require this technique) let's assume that the cathode resistor of one of the receiver i.f. amplifiers in the faulty set had gone high in value. During the comparison check we would alternately measure, first in the good receiver and then in the bad receiver, the resistance of each valve electrode to chassis. A high cathode bias resistor would soon become apparent with this approach. If resistance checks at all parts of the suspect stage or stages failed to indicate the whereabouts of the fault, we next applied power supplies to the two chassis and measured voltages in the same manner.

This procedure, which fell unashamedly into the "working in the dark" category, quite often produced results where all else had failed.

I was therefore very interested to find that my service manager friend occasionally employs this idea with television receivers when all other attempts at tracing a fault have proved unsuccessful. It is, of course, necessary to have a good receiver of the same type as the faulty one, but this is not too difficult in service workshops where a fairly small range of makes is handled. It is also necessary to make certain that the potentiometers and switches in both chassis are set to the same position, as different settings here may introduce misleading discrepancies.

The comparison idea can, incidentally, be quite useful with printed circuit boards, as the comparative tests may be made to corresponding points on the copper patterns without having to bother about the actual circuit points to which they correspond. It is only necessary to start circuit tracing when a discrepancy has been found.

Audio Developments

The accompanying photograph illustrates a new record changer, the Model 3000 LM, which is manufactured by Garrard Engineering Ltd. This unit has been successful in the highly competitive American market and is now being introduced in Britain. A new development is the use of a low mass pick-up arm, this enabling the pick-up cartridge to give a true performance unimpaired by arm resonance and mass. The arm, designed for use with high quality stereo pick-up cartridges having low tip mass and high stylus compliance, offers an exceptional tracking ability. This ability is maintained in the vertical direction also, and warped discs are reproduced with the minimum amount of wow. The Model 3000 LM will play up to eight records automatically in mixed sizes at 16⅔, 33⅓, 45 or 78 r.p.m.

The Garrard record changer Model 3000 LM. The specially developed pick-up arm ensures that pick-up performance is unimpaired by arm mass or resonance.

Also just introduced by Garrard is a battery operated version of their Autoslim changer. Battery operated units of this type tend to give trouble due to the oxidation of the governor contacts and the copper commutator segments of the motor, but this problem has been overcome in the Garrard changer by using an alloy of nickel and gold for the governor contacts and a special silver alloy for the commutator segments. The motor fitted is the new Model 32BM, which has been designed specifically as a drive unit for sound reproducing equipment. Current consumption is stated to be less than that of a flash lamp bulb.

Electric Vehicle Charging

One of the problems which arise with vehicles propelled by their own storage batteries is the difficulty of efficient charging at high currents when the vehicle is at rest. Unless care is taken to reduce current abruptly as the storage battery approaches maximum charge, it is possible for overcharging to take place. Also, placing reliance on battery terminal voltage to control the charge may cause an unnecessary reduction in charging current before the charge is finally complete. The result is that charging time is partly wasted.

A development which overcomes these problems and which is suitable for lead-acid batteries has been introduced by Harmer and Simmons Ltd.; and it was demonstrated at the 1964 A.S.E.E. Electrical Engineers Exhibition held at Earls Court from 18th to 25th March. The Harmer and Simmons "Cyclocat" rapid charger is controlled by a probe which monitors the amount of gassing occurring in the battery. A charge of 27 amps is applied to the battery until gassing commences, at which point the probe reduces the charge by an amount depending on the quantity of hydrogen involved, and continues to do so until the charging current is reduced to a trickle that the battery can withstand for very long periods. In this manner the "Cyclocat" automatically gives the optimum charge throughout the charging period. Since there is a minimum of gassing and the temperature of the electrolyte does not rise unduly, topping up is cut down also.

The unit incorporates an electronic control circuit, is completely static and requires virtually no maintenance. It is continuously rated, and is designed to withstand the vibration which may occur when it is mounted on a vehicle. It measures 13¼ x 13¼ x 9in and weighs 90lb. The unit is suitable for charging 24 lead-acid cells (48 volts) from a 200 to 250 volt 50 c/s mains supply, and may operate from any standard 13 amp domestic socket outlet.

THE NEW DUAL-STANDARD TV SETS

By Gordon J. King, Assoc. Brit. I.R.E., M.T.S., M.I.P.R.E. **PART 1**

This is the first of an important new series which fully describes the 405–625 line television receivers currently appearing on the market. This article introduces the subject of 405–625 line reception by examining the two signals

IN THIS NEW SERIES OF ARTICLES IT IS PROPOSED TO investigate the recently launched 625 line television system, to compare it with the old 405 line system and to examine some of the circuits which are used in the new dual standard models.

The best place to start is at the signal itself, so let us recapitulate on the old 405 line signal. The most significant feature of this signal is that the modulation is positive-going, as shown in Fig. 1 (*a*). At (*b*) is shown the signal after rectification (detection).

From these diagrams it may be seen that the transmitted power rises towards peak white and that the power is almost zero at the base of the sync pulses.

Vision Modulation

The British 625 line signal differs in this fundamental concept in that the modulation is negative-going. Negative modulation is shown in Fig. 2, the transmitted waveform at (*a*) and the demodulated waveform at (*b*).

At Fig. 1 (*b*) it is seen that zero modulation occurs at the base of the sync pulses, that the modulation is at 30% level at black and at 100% level at peak white. At Fig. 2 (*b*) a significant factor is that zero modulation is not at peak white level, but that at peak white the modulation is about 16% (some authorities quote this as 10%).* This prevents the d.c. potential due to the signal across the video detector load from dropping right to zero at peak white, a factor that can prove useful from the practical aspects of the video circuitry, as we shall understand later.

Apart from the polarity of the modulation, the two signals differ in other respects. A 405 signal, for example, has a line repetition frequency of 10,125 c/s while that of a 625 signal is 15,625 c/s. The British 405 and 625 standards both use a field repetition frequency of 50 c/s, because this matches the power supply frequency and avoids problems arising from asynchronous working.

Lines and Fields

A complete picture on either standard is composed of two interlaced fields, each field comprising exactly half the number of lines of a complete picture. Thus, a 405 field has 202½ lines and a 625

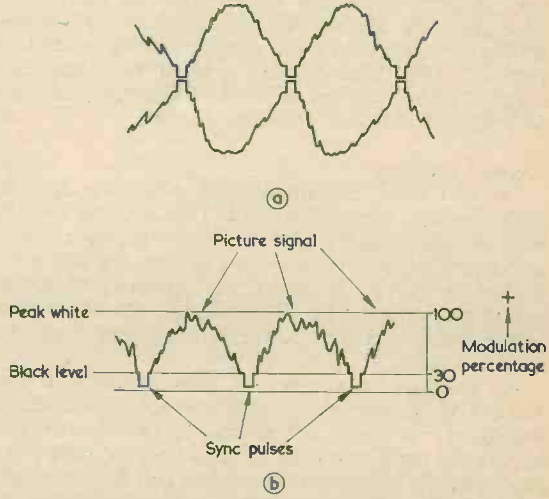


Fig. 1. Transmitted vision waveform of the 405 line signal. Note, in (a), that the modulation depth increases with increase in white signal. At (b) is shown the 405 vision signal after demodulation; also approximate modulation percentages

* The 625 line parameters quoted by the B.B.C. in 1962 stated a blanking level of 72.5 to 77.5% of full modulation, and a peak white level of 10 to 12.5%.—EDITOR.

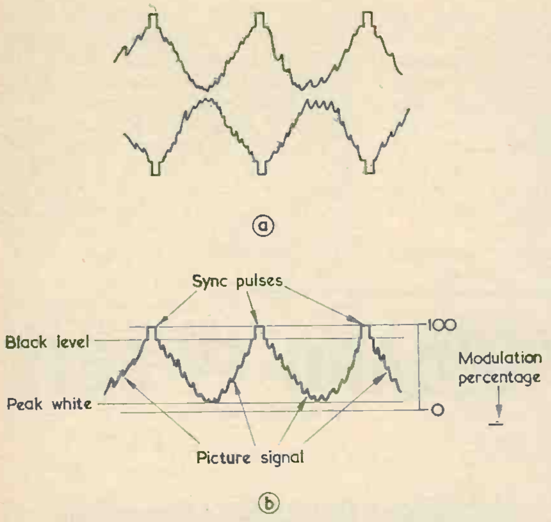


Fig. 2. Transmitted vision waveform of the 625 line signal. Note here that the modulation depth decreases with increase in white signal, maximum modulation occurring at the tips of the sync pulses (a). At (b) is shown the signal after demodulation

field 312½ lines. Not all of these lines carry active picture elements, since a few of them occur during the field sync pulse period when the picture signal does not rise above black level.

The line repetition frequency is given by multiplying the number of lines of a field by the field frequency. Try this and you will find that you get the frequencies given above.

Since the field frequency is unchanged it follows, of course, that the scanning spot must sweep horizontally across the screen to trace out a line of a 625 line picture in approximately two-thirds of the time taken to trace out the line of a 405 line picture. Line period times are, in fact, approximately 100 microseconds for a 405 line picture and 64 microseconds for a 625 line picture.

Carrier Spacing

On 405 lines the sound and vision carriers as transmitted are separated by 3.5 Mc/s while on 625 lines the separation is 6 Mc/s. There is also another important distinction and that is that on 405 lines the vision carrier is higher in frequency than the sound carrier while on 625 lines the opposite is true—the vision carrier is lower in frequency than the sound carrier.

An increase in number of lines means that the *vertical* definition of a picture is automatically improved. It does not mean, however, that the horizontal definition is likewise improved. The only way that the horizontal definition can be improved is by arranging the complete television chain—from camera to picture tube—so that its response to *changes* in picture element brightness is speeded up.

We have seen that on 625 lines the scanning spot travels horizontally across the tube face about 30% faster than on 405 lines. Now, if the rate of change of brightness of the scanning spot on 625 lines is limited to that set for a top value on 405 definition, the effect will be an apparent decrease in 625 definition, since the spot will have covered a greater distance on 625 lines for a maximum rate of change of brightness as established by the 405-line system. (It should be remembered, of course, that it is the *speed* at which the *brightness* of the scanning spot can change which defines thin, vertical picture elements.)

In other words, simply to retain the original 405 horizontal definition on 625 lines the rate of change of brightness of the scanning spot should be increased in proportion to the increase in scanning spot velocity.

We must remember, though, that the increase in number of lines has improved the vertical definition, so we require more than just a restoration of the horizontal definition. We require an improvement over the 405 definition to match the better vertical definition!

Horizontal Definition and Bandwidth

The rate at which the scanning spot on the picture tube screen can change in brightness is governed by the overall bandwidth of the television system as a whole. An instantaneous change in brightness of a picture element theoretically requires an instantaneous change in brightness of the scanning spot. But an instantaneous change of current through a circuit or change of voltage across a load just cannot be accommodated, since this would necessitate a bandwidth from d.c. to infinity!

Look at Fig. 3. At (*a*) is shown a pulse of brightness plotted against time which could, in fact, represent an element of the picture as "seen" by the camera tube. At one instant in time the pulse represents both zero brightness and maximum brightness. It then stays at maximum brightness for the period of the pulse, after which it falls to zero brightness in zero time. Actually, this is an impossible pulse, but it does, at least, serve to illustrate the definition aspect of television.

At (*b*) we have "geared" the brightness pulse to a voltage pulse, the voltage being zero at zero brightness and maximum at maximum brightness. Here we see that it takes a little while for the voltage to build up to a maximum, which it does by following a curve. Likewise, at the finish of the brightness pulse the voltage takes a little while to fall back to zero again, and follows a similar curve as before.

Now, when it is remembered that the brightness of the scanning spot in the picture tube follows the curve at (*b*) and *not* that at (*a*), it can be understood why there is a limit to the horizontal definition. This is shown better at (*c*). Here the voltage change due to brightness change is considerably more distorted and suppressed.

The greater the bandwidth of the vision channel throughout the television system, the more faithfully will the change in brightness of the scanning spot follow the change in brightness of a picture element.

For the 405 line standard the horizontal definition approximately equals the vertical definition when the bandwidth of the vision channel is about 3 Mc/s. If something happens in the receiver to reduce the bandwidth, then the horizontal definition falls below the vertical definition. In this case the fine detail of a picture may not cause any voltage output at all, or a very small, distorted output, as shown in Fig. 3 (*c*). The voltage output at (*b*) would be quite acceptable from a highly defined brightness pulse as at (*a*).

To give the same 405 definition on 625 lines, it follows that the bandwidth should be raised to about 4.5 Mc/s. This is true, but since it is required to *improve* on the 405 definition, a vision bandwidth of about 5.5 Mc/s is used on the 625-line standard.

To accommodate this greater bandwidth and the greater spacing between the sound and vision carriers, a 625 channel has an overall width of 8 Mc/s as compared with the 5 Mc/s channel width of the 405-line system.

So much for the vision signal. On sound there is one fundamental difference between the two standards. That is, amplitude modulation is used on 405 lines and frequency modulation on 625 lines. A.M. is used for both vision signals.

The parameters of the two signals are compared in Table I.

Now that we know more about the two signals, we must go back to the aerial or input, for it is here that the first major difference between the two standards is encountered.

TABLE I

Parameters	405	625
Number of lines per field ..	202½	312½
Number of fields per picture	2	2
Line repetition frequency ..	10,125 c/s	15,625 c/s
Approximate line period ..	100 μS	64 μS
Vision modulation	A.M. positive	A.M. negative
Vision/sound carrier spacing	3.5 Mc/s	6 Mc/s
Carrier relationship ..	Vision above sound	Sound above vision
Channel width	5 Mc/s	8 Mc/s
Vision bandwidth	Approx. 3 Mc/s	Approx. 5.5 Mc/s
Sound modulation	A.M.	F.M.

Bands and Channels

So far, the 405 line programmes are accommodated in the thirteen channels of the v.h.f. (very high frequency) Bands I and III, while the 625 line programmes are accommodated in the forty-four channels of the u.h.f. (ultra high frequency) Bands IV and V.

Band I extends from 41 to 68 Mc/s and holds five 5 Mc/s channels, Band III extends from 174 to 216 Mc/s and holds eight 5 Mc/s channels, Band IV extends from 470 to 582 Mc/s and holds fourteen 8 Mc/s channels and Band V extends from 614 to 854 Mc/s and holds thirty 8 Mc/s channels.

Band II is not, of course, used for television broadcasting at all, it being concerned with f.m. sound broadcasting over the spectrum of from 87 to 100 Mc/s approximately. Band II does not concern us in this series of articles.

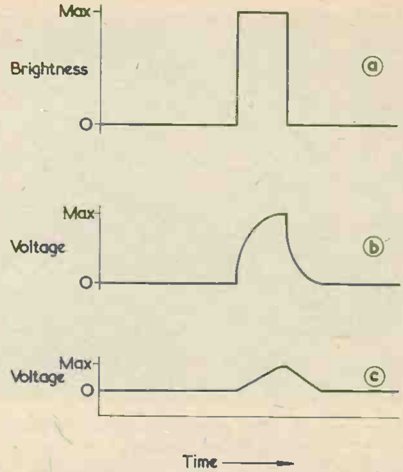


Fig. 3. The bandwidth of a television system dictates how accurately the change in brightness of the scanning spot on the picture tube screen is tied to the instantaneous brightness of the picture element as "seen" by the camera tube. At (a) is a pulse of brightness which changes (for the sake of illustration) from zero to maximum in zero time. In (b) the voltage caused by the brightness change follows a curve to maximum and a reciprocal of the curve from maximum to zero. This would give reasonable definition. Bandwidth restriction, however, could distort and suppress the voltage change to that shown at (c). Such a response would give very poor horizontal definition

The final plan for national coverage of the 625 programmes has now been established. Each area is allocated four u.h.f. channels whose channel numbers (frequencies) have been carefully chosen to avoid or minimise co-channel, adjacent channel and other beat interference effects. Thus, we have the selected channels for a given area which are separated by predetermined guard channels.

In some areas, typically London and Suffolk, the four channels are accommodated in a spectrum of 88 Mc/s (e.g. four channels being used out of a total of eleven channels—eleven 8 Mc/s channels equal 88 Mc/s). In other areas a far wider spectrum is necessary to accommodate the four selected channels. In West Sussex, for example, a spectrum of 312 Mc/s is used, embracing Channels 27, 55, 58 and 66.

In the London area Channels 23, 26, 30 and 33 have been chosen, and Channel 33 is the first to go on the air. It is the general idea initially to put only one of the four allocated channels on the air in any one area.

The first u.h.f. channel made operational in any area will carry BBC2, the second operational channel ITV2 and the two remaining channels could later—possibly on a temporary basis while the whole TV system is changing over to 625 lines—

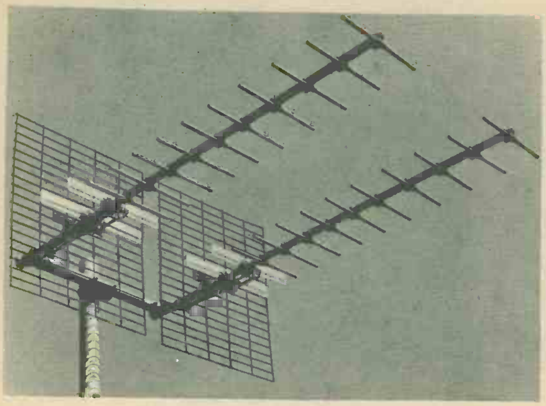


Fig. 4. A pair of Yagi arrays in stack formation. (Belling & Lee Limited)

carry BBC1 and ITV1. It is also likely that colour will be launched on one of the u.h.f. channels.

Polarisation

V.H.F. television commenced operations with vertically polarised transmitters. Later, horizontal polarisation was introduced to alleviate co-channel interference (interference resulting from the use of a common channel by two or more stations).

U.H.F. television is to commence operations with horizontally polarised transmitters, though later there is the possibility that some booster stations may have to employ vertical polarisation to avoid interference troubles.

The London station on Channel 33 will run at a power of 0.5 megawatt at sound and vision carrier frequencies of 573.25 Mc/s and 567.25 Mc/s respectively. This is the last but one channel in *Band IV*—the top channel being No. 34. The mean wavelength of Channel 33 is in the order of 54 centimetres, and the length of the dipole is about 95% of half the wavelength (the 95% reduction is due to the slight decrease in velocity of the wave on passing through the aerial).

U.H.F. Aerial

Generally, therefore, the u.h.f. dipole is about one-eleventh the length of the v.h.f. Band I dipole. The "signal grip" on the u.h.f. channels, then, is approximately one-eleventh of that on the Band I channels. This means that it is essential in almost all areas to enlarge the u.h.f. aerial metalwork by the addition of directors and a reflector system. Some u.h.f. aerials have 32 elements in all, though the reflector system, even when it comprises a number of elements, is looked upon as just a single element by manufacturers and dealers, as a means of standardisation.

The Yagi array is the most popular and sometimes two or four arrays are stacked and connected for signal addition. Two arrays stacked are shown in Fig. 4. Here co-linear dipoles and mesh reflectors are also featured. Adding elements and stacking not only increase the gain but also the directivity. High directivity is often desirable on the u.h.f. channels to provide high discrimination against reflected signals.

The possibility of reflection increases with increase in frequency for two reasons. One is that there are many more potential reflectors at u.h.f. (any conducting object in excess of half a wavelength can act as a reflector) and the second is that u.h.f. signals behave more like light rays from the reflection aspect than do v.h.f. signals.

U.H.F. aerials have an inherently wider bandwidth than comparable v.h.f. aerials, and it is not unduly difficult to design for a bandwidth of 88 Mc/s or more. Thus, in many areas just a single array will ultimately be responsive to the signals from the four u.h.f. channels. London area aerials now being sold embrace Channels 23 to 33. It is hoped, of course, that all the stations of a local group will be co-sited—like the three or four stations of a group of f.m. transmitters.

Co-siting may not always be possible, so that in some cases two or more separate aerials may be needed to receive the four local channels, but this condition does not yet arise. Separate, highly-tuned 8 Mc/s wide arrays may also be needed to get the best results in poor reception areas, and there will be many of these to start with.

Transistorised boosters will become popular, not only for u.h.f. but also for v.h.f., the latter to allow the use of indoor or attic v.h.f. aerials, so that the chimney stack can be used to accommodate the more critical u.h.f. arrays.

So far, then, we have seen how the new 625 line signals compare with the old 405 line signals and also how the channels differ. Next month we shall commence a stage-by-stage comparison of the receiver circuits, eventually revealing how modern receivers are cleverly designed to switch from one standard to another without deterioration in performance.

(To be continued)

NEW RANGE OF ZENER DIODES INTRODUCED BY MULLARD

Mullard have introduced a new range of close-tolerance zener diodes rated for a maximum power dissipation of 400mW at an ambient temperature of 25°C. At present the range comprises fourteen types with zener voltages between 4.3V and 15V. The diodes are suitable for use in voltage reference circuits, coupling and bias circuits for d.c. amplifiers, and as voltage-shift elements in digital circuits. They are housed in all-glass sub-miniature encapsulation (DO-7).

New Type Numbering System

In common with Mullard semiconductor power devices (i.e. thyristors and rectifier diodes), zener diodes now have a type number which, as well as identifying the device also indicates its characteristics.

Zener diodes with the same current rating will be given a range number—the 400mA series having a range number BZY88. Individual diodes with different voltage ratings will then be identified by adding further letters and figures to the range number. For example, in the case of BZY88-C4V3, C indicates a nominal Zener-voltage tolerance of ±5%, V replaces the decimal point and the figures indicate an operating voltage of 4.3.

SIMPLE OHMMETER

I. M. REES

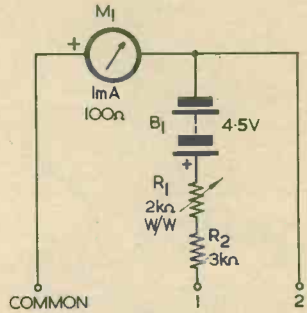


Fig. 1. The circuit of the dual-range ohmmeter

Due to its cheapness and simplicity, the ohmmeter described here will be found ideal for both the beginner or the experienced constructor who requires a simple but efficient instrument which can, in many cases, be built from the spares box.

One of the main difficulties experienced by the writer in constructing ohmmeters is the hand-engraving of meter scales. This has been dispensed with in the present design and the constructor will find a ready-calibrated conversion scale available in Fig. 2. This can be either copied or cut out and stuck on to the instrument panel. All that is then required is to compare the meter deflection against the chart to obtain a direct ohms readings.

The Circuit

The circuit appears in Fig. 1 and, as can be seen, is quite conventional. Two ranges are available, these being 0–100kΩ and 0–2kΩ.

No range switch is incorporated, and this function is carried out by the special linked test lead shown in Fig. 3.

Components List

Basic Instrument

- M_1 0–1mA, moving coil meter, 100Ω internal resistance
- R_1 2kΩ pre-set potentiometer, wirewound
- R_2 3kΩ carbon, ¼ watt, 20%
- B_1 4.5 volt flat torch battery

With Modification

- R_3 4.7kΩ carbon, ¼ watt, 20%
- B_2 As B_1

The higher range is selected by plugging the linked test lead into the socket marked "common" and leaving the link free. The other single test lead is then plugged into socket 1. In order to take a reading the instrument must first be adjusted for full scale deflection, this being done by short-circuiting the ends of the test leads and adjusting R_1. Resistance is then read by comparing the deflection of the meter against the conversion scale.

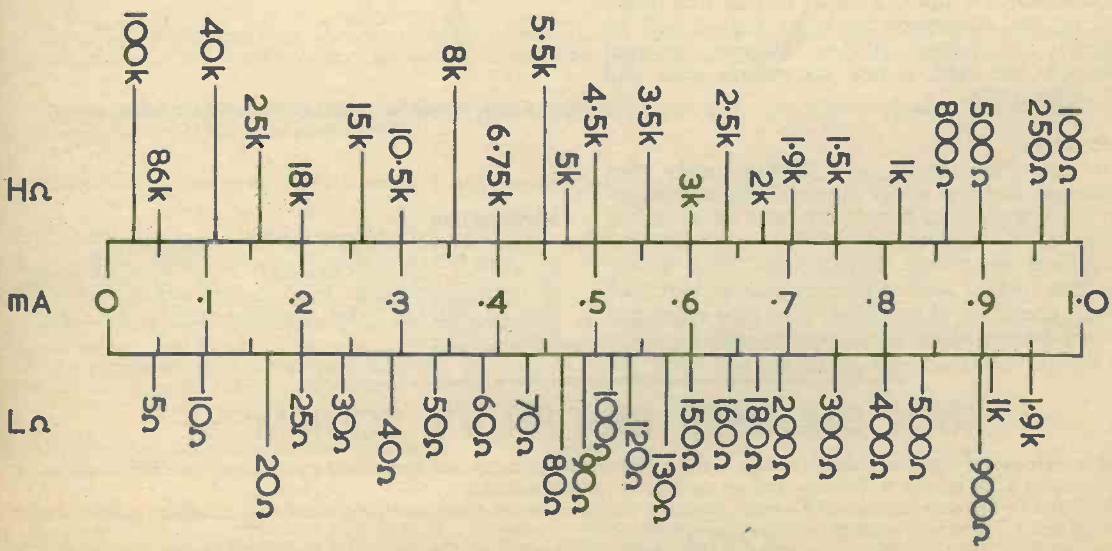


Fig. 2. The conversion scale. This may be cut out, or copied

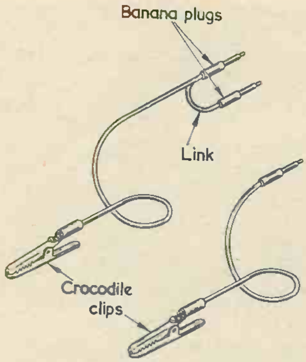


Fig. 3. The test leads. For low ohms readings the linked plugs are inserted into the "common" socket and socket 1. The remaining plug is inserted into socket 2

On the lower range the linked lead is left in the "common" socket and the link is inserted into socket 1. The other single lead is then plugged into socket 2. On this range, and with the test leads open-circuit, the meter will be at full scale deflection (if not adjust by means of R_1). The actual value of resistance is then indicated and read as before.

It is obvious that, on the high ohms range, the resistance under test is in series, thereby limiting the flow of current through the meter. On the low ohms range the resistance under test shunts the meter.

Note that when connected for low ohms measurement the battery is connected permanently in circuit; thus it is wise to disconnect the leads when not in use in order to conserve the battery.

It will be seen that the Components List specifies a meter having an internal resistance of 100Ω. It is essential to employ a meter having this resistance, or the conversion scale of Fig. 2 will be incorrect. If meters having different internal resistances are used, a new conversion scale will need to be made.

Construction

Any suitable layout will accommodate this instrument, and the writer chose a simple arrangement using a piece of aluminium bent up as shown in Fig. 4. A 2½in meter was to hand and the appropriate hole and fixings were then made. The three sockets should be arranged as indicated to avoid crossover of the leads. The type employed were insulated sockets which are secured by single nuts. The potentiometer should preferably be of the wirewound variety and need be a pre-set component only, as occasional adjustments are all that will be necessary when the battery voltage falls. Enough room should be left under the potentiometer for the conversion scale. As the life of the battery is very long the connections to it can be soldered, the battery itself being held in position by an elastic band. Ensure that the polarity of the battery is correct before connection.

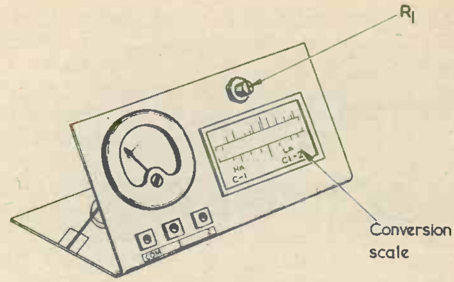


Fig. 4. The simple layout adopted for the prototype

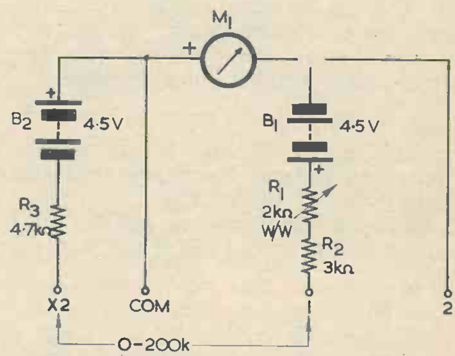


Fig. 5. A modified circuit which allows the measurement of resistance up to 200kΩ

Modification

The simple addition of a series resistor and a second 4.5 volt battery makes possible an extension of the higher range by a multiplication factor of two (0–200kΩ). The modified circuit appears in Fig. 5.

IRAN CHOOSES BRITISH TV EQUIPMENT

Government of Iran has ordered image orthicon television cameras and associated equipment from EMI Electronics Ltd., to equip a TV studio in Teheran and an outside broadcast vehicle.

Included in the contract are EMI's new transistor modular sound equipment, vision mixing consoles, several studio monitors and a Transicom intercommunication system.

Negotiations for this contract, worth £33,000, were conducted in conjunction with Ampex International of Fribourg, Switzerland, who will provide videotape recording equipment.

Stereophonic Broadcasting

A review has recently been made by the B.B.C. of the possible future of stereophonic broadcasting in this country, taking into account the results of the experimental work that has been done, the response to the experimental transmissions, and the fact that stereophonic broadcasting has been introduced in the U.S.A. and Canada and that regular experimental transmissions are being made in Germany and Holland.

The B.B.C. believes that stereophony can produce a worthwhile improvement in reproduction, especially of music, and believes that there is a demand for it, which, though a minority demand, is nevertheless substantial. Stereophonic broadcasting on the VHF network would encourage VHF listening, would provide a new market for receivers and would no doubt assist the industry in its export trade. It is obvious, however, that no definite plans can be made to introduce stereophonic broadcasting until the system to be used has been decided upon.

The adoption of a common system for general use in Europe was considered by the C.C.I.R. in February 1963, but no recommendation was made. The question will no doubt be considered again at the interim meeting of the C.C.I.R. Study Group in the spring of 1965, but it now seems unlikely that the C.C.I.R. will agree upon a European system until its next Plenary Assembly in 1966. If a recommendation is made then it would be necessary to obtain the approval of the Postmaster-General to the introduction of stereophonic broadcasting in this country and he would no doubt wish to receive the advice of his Television Advisory Committee.

Meanwhile the B.B.C. proposes to continue the present experimental dual-transmitter transmissions during the winter months up to the time of the C.C.I.R. meeting in 1966 and also to continue the experimental compatible transmissions from Wrotham. In each case it may be necessary to alter the schedule of transmissions as a result of changes in the hours of transmissions of normal programmes.

The B.B.C. will continue to study the technical problems affecting the introduction of a stereophonic service, so that the situation can be reviewed if there are any significant developments.

Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. Queries should be submitted in writing.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers, as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Contributions on constructional matters are invited, especially when they describe the building of particular items of equipment. Articles should be written on one side of the sheet only and should preferably be typewritten, diagrams being on separate sheets. Whether handwritten or typewritten, lines should be double-spaced. Diagrams need not be large or perfectly drawn, as our draughtsmen will re-draw in most cases, but all relevant information should be included. Photographs should be clear and accompanied by negatives. Details of topical ideas and techniques are also welcomed and, if the contributor so wishes, will be re-written by our staff into article form. All contributions must be accompanied by a stamped addressed envelope for reply or return, and should bear the sender's name and address. Payment is made for all material published.

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SMALL ADVERTISEMENTS

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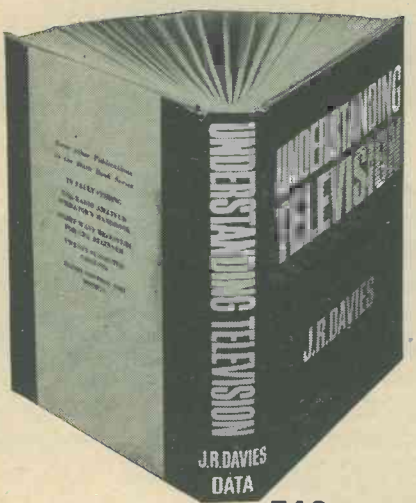

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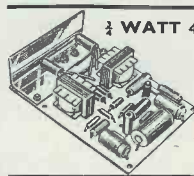

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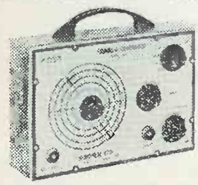

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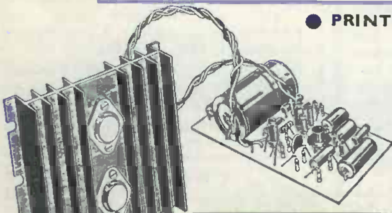

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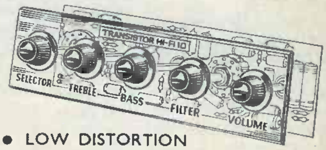

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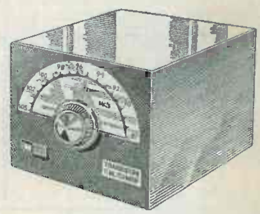

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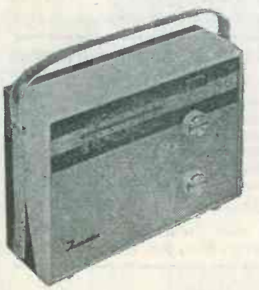

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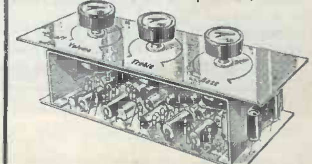

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